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DIVISION 700 - MATERIALS CONTROL

SECTION 701 - PURPOSES OF MATERIALS CONTROL

701.1 – COMPLIANCE WITH SPECIFICATIONS

An adequate and effective system for control of the materials used in a project is essential to ensure that the materials furnished and the completed work produced by the Contractor conform with the requirements of the Plans, Specifications, and Special Provisions, or are in reasonably close conformity, if permitted by the Specifications.

Control includes inspecting, sampling, testing, measuring, reporting of results, and any follow-up that may be necessary, especially in the case of test failures. Without any one of these actions, it is impossible for the Contract Administrator to have a complete and positive verification of compliance to the Plans, Specifications, and Special Provisions by the Contractor.

701.2 – UNIFORM RELATIONS WITH CONTRACTORS

The Plans, Specifications, and Special Provisions provide an equitable basis for bidding by Contractors, since they define the minimum requirements that are to be met. The Contractor is obligated to furnish materials and completed work that will equal or exceed such requirements.

The Contract Administrator must be satisfied, through materials control measures, that the State is receiving what it is entitled to under the Contract. The Contract Administrator should accept nothing less. To do so would not only be a disservice to the State, but would also be giving undue advantage to the Contractor. Other Contractors that had bid on the same work could contend that they would have offered a lower bid had they been able to anticipate that materials or work outside of the Specifications would be accepted.

It is essential that uniform materials control be applied by all Contract Administrators and inspectors from project to project, so that all Contractors and Suppliers are treated alike. To begin with, the Plans and Specifications should be prepared so that there will be the least possible difference of interpretation by Contractors and Department personnel. Beyond that, this Construction Manual provides guidance to Contract Administrators and Inspectors on the interpretation of the Specifications and the application of the materials control measures.

701.3 – DOCUMENTATION FOR EXPENDITURE OF PUBLIC FUNDS

When payment is to be made to the Contractor for materials furnished and work performed, the designated State officials must authorize disbursement of public funds for this purpose. The disbursing officer must depend upon others for evidence to support the expenditure. Through the materials control process, the Contract Administrator will acquire substantiating data, in the form of Certificates of Compliance, test results, inspection records and measurements necessary to justify the acceptance of the Contractor's work. Thus, the Contract Administrator shall be assured that the Contractor's obligation to provide the quality of material specified in the Contract is fulfilled, and the Contract Administrator can furnish documentation to the officials responsible for authorizing payment that the Contractor is entitled to full payment.

In case of failure to meet the specified requirements, the materials control data will constitute the basis for rejection of work deemed unfit for acceptance, or it may be the

basis for acceptance upon appropriate contract price adjustment, where this is permitted under the provisions of the Specifications.

Complete records, including Certificates of Compliance, measurements of work, and test and inspection reports covering acceptance or rejection, should be maintained in the project files. Copies should be furnished to the appropriate headquarters personnel for verification and as supporting evidence for payment documents.

SECTION 702 - GENERAL PROCEDURES OF MATERIALS CONTROL

702.1 – DEFINITIONS OF ITEMS

A. Acceptance Sampling and Testing

All of the samples and tests performed by the Department project personnel or an approved Department representative (unless noted otherwise) are used for determining the quality and acceptability of materials and workmanship which have been or are being incorporated into the project. Acceptance tests determine the conformance of the material to the Contract Specifications. The results are used to determine acceptance or rejection and may be used to adjust the level of pay for the material.

B. Independent Assurance Program

Independent samples and tests or observation of test procedures are performed by the Bureau of Materials and Research (LAB) personnel who do not normally have direct responsibility for process control and Acceptance Sampling and Testing. The Independent Assurance Program is used for the purpose of making independent checks on the reliability of the results obtained in Acceptance Sampling and Testing and not for determining the quality and acceptability of the materials and workmanship directly.

C. Verification Samples and Tests

Samples and tests performed by the LAB personnel verify the results of certified tests or manufacturer's Certificates of Compliance for manufactured materials.

D. Process Control

This constitutes the inspection of equipment as well as sampling and testing procedures performed by the Contractor to control construction operations. State personnel may assist with process control as defined in the "NHDOT Guide to Frequency of Sampling and Testing" (TEST GUIDE). The TEST GUIDE may be found in Section 703.4 of this manual.

E. Source Approval

The review and inspection of material sources is performed to ensure that the facility is capable of producing materials that will meet Specifications. Source approval includes inspection of the facilities, review of the source's quality control plan, and actual testing of the material produced. Sources include material mixture plants, producers of manufactured products, or may be naturally occurring. Preliminary approval at this level does not constitute acceptance because all final material acceptance tests are preformed on in place materials.

702.2 – SPECIFICATIONS AND THEIR APPLICATION

Specifications are prepared to define the minimum requirements for materials that are considered suitable for specific purposes. When materials are furnished to meet these Specifications, tests must be made on the materials and compared against the requirements to determine acceptability. When this is not practical, materials may be accepted by a Certificate of Compliance or by being on the Department's Qualified Products List. (Materials on the Qualified Products List still require a Certificate of Compliance.) All manmade materials manufactured offsite require a Certificate of Compliance.

Sampling, testing, and taking measurements must be done strictly in accordance with the procedures that are prescribed in the Specifications. Failure to comply with any of the required procedures can lead to serious discrepancies in the results.

702.3 – INSPECTOR'S RESPONSIBILITY: ACCEPTANCE SAMPLING AND TESTING

Acceptance sampling and testing is the responsibility of the Contract Administrator and will be conducted by Department project personnel or a representative employed by the Department who is responsible for the day-to-day inspection. No material should be incorporated into the work that has not been inspected, tested, and approved, unless it is listed on the Department's Qualified Products List.

Conditional acceptance of certain materials may be permitted when produced by a manufacturer having a good record of compliance. Materials of this type include Portland cement, bituminous materials, certain aggregates, culvert pipe, and other selected items.

Therefore, the inspector is obligated to know which materials must be sampled, when and where samples must be taken, the sizes of samples required, the proper methods for obtaining samples, and the proper procedures for testing the samples. The Department's TEST GUIDE should be consulted for determining the frequency of performing Acceptance Sampling and Testing. The TEST GUIDE may be found in Section 703.4 of this manual.

702.4 – MATERIAL ACCEPTANCE

Acceptance of materials may be made on the basis of one or more of the following:

a. Sampling and Testing Acceptance. Sampling and testing for final acceptance will be done at the project on materials in place. Preliminary acceptance by sampling and testing can be either source testing, such as for wear tests, or inspection of items such as concrete pipe and structural steel.

b. Certification Acceptance. Materials may be accepted based upon a Certificate of Compliance only; a Certificate of Compliance and verification tests as defined by the TEST GUIDE; being listed on the Qualified Products List together with a Certificate of Compliance as required by the Specifications; or by consultant inspection.

c. Field Inspection Acceptance. Materials such as granite, fieldstone, mulch and other natural materials not requiring testing or certifications, as designated by the District Construction Engineer, may be accepted by field inspection.

1. Sampling, Testing, and Preliminary Approval of Materials prior to Incorporation into the Work:

a. Manufactured Materials Tested at the Plant or at the Time of Field Delivery: This applies to the sampling and testing of manufactured materials which cannot practically be tested before incorporation into the work. Materials such as cement, concrete, and asphalt are included in this phase. This "initial" sampling and testing at the plant or at the time of delivery to the project site does not preclude the taking of samples or measurements of these manufactured materials in place when necessary.

The Contractor shall identify the sources of all manufactured materials. Samples for testing shall be submitted, or facilities shall be provided for sampling and testing, or both, as required in accordance with Specifications. Additional samples may be submitted by the Contractor or the Contract Administrator for progress reports as necessary to ensure quality control. Project personnel may assist the Contractor in the taking of samples and by identifying, packaging, and forwarding the samples to the LAB for testing.

For materials requiring Certificates of Compliance, the Certificates should be submitted at the time of field delivery. The Contract Administrator will retain a copy of each Certificate of Compliance for the permanent project records. No payment will be made for any material until the required Certificate of Compliance has been received. It is important to note that some Certificates will cover only a partial quantity of the total item (i.e., reinforcing steel) and therefore payment for quantities above the certified amount shall not be made until additional Certificates have been received.

b. Natural and Processed Materials: This covers the initial sampling and preliminary approval of all natural and processed materials and their sources before being incorporated into the work. Examples of these materials are borrow, sand, gravel, and crushed gravel. This "initial" sampling does not preclude additional sampling and in-place testing, as specified by the TEST GUIDE. An exception to this is the stone wear test, which is generally not repeated after preliminary approval unless the material changes. The Contractor shall identify the source(s) of all natural and processed material expected to be used. The Department may test the initial samples for informational purposes only.

If material sampled either from the gravel pit or the initial stockpile does not meet specifications, any continuation of operations is entirely at the Contractor's risk.

2. Sampling, Testing, and Approval of Material and Workmanship In Place: Except for those materials which are impractical to test after incorporation into the work, the TEST GUIDE (see Section 703.4) will be the basis for determining the quality of material. This determination is accomplished by sampling and testing the finished work in place. This in place sampling and testing is necessary to ensure that the material application or placement techniques have not significantly altered the material characteristics upon which the initial approval was based.

The test results should be made available to the Contractor for information and appropriate action.

702.5 – INDEPENDENT ASSURANCE SAMPLING AND TESTING

These tests are to be performed by personnel from the Bureau of Materials and Research to ensure that proper procedures and equipment are being used by Project personnel when they perform Acceptance Sampling and Testing. The intent is to have two independent sets of tests run on similar samples, such that a direct comparison of test results will indicate divergence from or conformance to the specified testing procedures. To achieve this, split sampling should be used with personnel from the Project and the Bureau of Materials and Research present. The location of the sampling will be as required in the TEST GUIDE. The TEST GUIDE may be found in Section 703.4 of this manual.

Independent Assurance Sampling and Testing may be done by observation of Acceptance Sampling and Testing procedures. However, most of the tests must be performed by Bureau of Materials and Research personnel using calibrated equipment. When Independent Assurance tests are performed by observation of Acceptance Sampling and Testing, both the Acceptance Tester and the Independent Assurance Tester will sign the test report.

Independent Assurance personnel will make a prompt comparison of these sampling and testing results. Although the acceptability of the material is determined entirely by the Acceptance Sampling and Testing results, a "Guide to Acceptable Deviations" between the Acceptance Test results and Independent Assurance Test results has been established. This Guide may be found under Section 703.5 of this manual. Deviation beyond these prescribed limits will require a prompt review and resolution by Assurance personnel.

Some materials accepted on the basis of certified test results or Certificates of Compliance are also subject to verification sampling and testing by the Bureau of Materials and Research. This Independent Sampling and Testing verifies that the materials or products meet the supplier's claims as related to their Certificate of Compliance.

702.6 – NHDOT GUIDE TO FREQUENCY OF SAMPLING AND TESTING (TEST GUIDE)

The TEST GUIDE is provided for both Acceptance Sampling and Testing and Independent Assurance Sampling and Testing. It should be understood that the contents of the TEST GUIDE are guidelines and that the Contract Administrator should require additional sampling and testing as necessary to ensure the quality of materials incorporated in the work. The TEST GUIDE may be found in Section 703.4 of this manual.

702.7 – RECORDING, REPORTING, AND DOCUMENTATION

A. Recording and Reporting Procedure:

1. The Contract Administrator will:

a. Carefully and completely document all sampling and testing, together with the corrective action taken. This will enable the Department to completely justify the use of these materials and the results obtained.

b. Maintain a complete list for the permanent project records of all samples taken and tests, including field tests, made. This list should include the type, location, and date, and should indicate whether the sample was submitted by the Contractor or the Department.

c. Package samples for delivery to the LAB in accordance with the approved standard procedure. Be sure to note the source of the material and the location where the sample was taken.

d. Identify samples taken or requested by the FHWA by noting "FHWA's Sample report to FHWA and the Construction Bureau Administrator" on the shipping tag included with the sample.

e. Retain all test reports. If the report is unsatisfactory, note any corrective action on the Corrective Action Report. Retain the original copy for the project records, give one copy to the Contractor and forward one copy to the Bureau of Materials & Research only upon their request.

f. Fill out a Field Test Report on all field tests made. Retain the original copy for the project records, give one copy to the Contractor and forward one copy to the Bureau of Materials & Research only upon their request. Maintain a file of all work sheets used in field testing.

g. Record on the Corrective Action Report corrective action taken as a result of unsatisfactory field tests. This Report will become a part of the permanent project records. Retain the original copy for the project records, give one copy to the Contractor and forward one copy to the Bureau of Materials & Research only upon their request. Attach a copy of the unsatisfactory test report with each copy of the Corrective Action Report.

2. The Bureau of Materials and Research will furnish necessary personnel and special equipment to assist the Contract Administrator in performing any specialized tests required.

3. The FHWA may require specialized tests at certain locations as part of the testing program. The following is FHWA's procedure as it relates to these tests.

a. The FHWA will inspect the Contract Administrator's material test reports and observe construction methods during visits to projects. They will record and report their findings for the FHWA's Permanent Project Records.

b. The FHWA may request during visits to projects that samples be taken of any or all materials at random locations designated by them. Retain the original reports for the project records and forward the results of these tests to the FHWA for their Permanent Project Records.

4. The job of designating sources of material rests primarily with the Contractor. It is the Contractor's responsibility that all items meet the standards set forth in the Plans and Specifications and that all materials are furnished sufficiently in advance to be examined and receive preliminary approval. The Contractor should anticipate the need for sampling and testing.

SECTION 703 - MATERIALS SAMPLING AND TESTING

703.1 – SAMPLING AND TESTING PROGRAM

1. Acceptance Sampling and Testing shall be the responsibility of the Department's Contract Administrator, unless otherwise noted. Test reports will be generated according to the recommended frequency of acceptance testing as shown in the TEST GUIDE. The TEST GUIDE may be found under Section 703.4 of this manual.

2. Independent Assurance Sampling and Testing is to be performed by personnel from the Bureau of Materials and Research. The independent testing ensures that the proper sampling and testing methods are being followed, and that the testing equipment meets Specification requirements.

3. The location of the sampling shall be chosen as required in the TEST GUIDE. When split sampling is used, sampling must be performed in the presence of personnel from the LAB.

4. Independent Assurance Sampling and Testing can be done by observation, but at least 80 percent of the testing will be performed by LAB personnel using calibrated equipment. The sampling and testing of split samples and in-place densities will be documented. When Independent Assurance Tests are performed by observation, both the Acceptance Tester and the Independent Assurance Tester will sign the test report.

5. The Independent Assurance personnel will make a prompt comparison of test results. Any discrepancies between the results of the assurance and acceptance tests that are not within the acceptable range of deviations will be investigated, resolved, and documented.

6. Verification sampling and testing will be conducted by the LAB to verify that the results of certified tests or Certificates of Compliance are in compliance with the Specifications.

7. The Contractor is responsible for material process control. This includes maintaining production equipment in good working order, and all sampling and testing necessary to confirm that all materials being produced meet Specifications. NHDOT will assist the Contractor with process control to the extent defined in the TEST GUIDE.

8. The LAB is primarily responsible for source approval as outlined in the TEST GUIDE. This includes annual approval inspections of asphalt and concrete plants supplying NHDOT projects.

9. On small projects, defined as having 4000 cubic yards (3000 cubic meters) or less of select materials and/or embankment or if no provision is made for a lab facility in the Contract, the acceptance testing for soils and granular material will be done by the LAB, with no assurance testing required. A project may still be classified as being a small project if no more than one item exceeds 4000 cubic yards (3000 cubic meters), upon approval of the Bureau Administrators from the Construction Bureau and the Materials and Research Bureau.

10. A materials certificate will be prepared by the Materials and Research Bureau and submitted to the FHWA for each Federal-Aid construction project.

703.2 – DETAILS OF SAMPLING AND TESTING PROGRAM

A. Embankments (compaction)

1. Job Control - Compaction tests are to be made by project personnel at a recommended rate of one test per lift per 1500 feet (500 m) in length. This means that a fill 500 feet (150 m) long requires one compaction test for each 3 lifts.

This is an average frequency for testing. It is recommended that more frequent tests be made at the start of the project to determine the number of roller passes required to obtain the specified density. Once the required number of passes has been determined, fewer tests may be made in the same portion of the fill.

Each Proctor Density Curve shall be properly identified by number and source.

The station, distance right or left, elevation, and the applicable Proctor Curve Number shall be shown on each density test performed.

B. Sand

1. Job Control - Where sand is being used that is near the limits of the Specifications (i.e., silt content), more tests might be needed to ensure that the requirements are being met.

C. Gravel

Job Control - One sample should be obtained early and sent to the Lab and tested for L.A. Wear prior to approving of the quality of the source. All subsequent testing for gradation, density and compaction will be performed by project personnel on site.

The Contract Administrator should monitor the material coming from the gravel pit for changes. More testing may be required than what is shown in the TEST GUIDE (see Section 703.4). It is the Contractor's responsibility to supply material that passes the Specifications. This material will only be accepted after it has been placed and compacted to its required density.

D. Crushed Gravel

1. Job Control - Same as for Gravel, plus the percent of stones with fractured faces (by weight) must be determined.

2. Acceptance Test - Although this material may have met gradation requirements when sampled by the Contractor from the stockpile, it still may not be acceptable in place. Acceptance occurs only after the material has been placed and compacted to the required density.

E. Bituminous Pavement

1. Job Control - Aggregate from commercial sources for bituminous pavement shall be tested once per year. Aggregate produced on the project shall be sampled and tested by the Bureau of Materials and Research before use.

While the asphalt plant is operating, the hot bins shall be sampled at least once per day and the gradation of each bin shall be determined. Also, the cold feed piles shall be sampled periodically in order to maintain uniformity.

One sample of the completed mix is to be taken in the morning and one in the afternoon. Normally, the samples of the mix will be submitted to the Bureau of Materials and

Research for analysis unless sufficient personnel are assigned to the plant so that complete extraction tests may be made in the field laboratory. When extraction tests are performed at the field laboratory, all test reports shall be submitted to the LAB.

The plant inspector shall procure a copy of the refinery certificate for each load of asphalt cement delivered to the plant each day. The certificate, together with a one quart (one liter) sample of liquid from not more than two loads per day, shall be delivered to the LAB for viscosity testing. Marshall blocks of the surface course must be fabricated each morning and afternoon for submission to the LAB for testing. Marshall blocks are not required for base and binder mixtures.

F. Structural Concrete

1. Job Control - Aggregate from commercial sources for structural concrete should be tested annually by the Bureau of Materials and Research and the information should be furnished to the project. The Contract Administrator is advised to request this information if it has not been furnished.

Job control of concrete requires that additional testing of aggregates takes place at the batching plant. The Plant Inspector shall check the Fineness Modulus of the sand once per day and the moisture content of the aggregates should be checked daily or as needed.

Each day that concrete is placed, the Contract Administrator will check the slump and air content and make test cylinders. Two cylinders (minimum) per pour are sufficient for the substructure, but at least three cylinders are required for deck placements. Additional cylinders should be made when early breaks are required.

Be sure to check that each transit mix truck has been approved for use, as evidenced by the current year's seal attached to each vehicle.

2. Refer to the chart in the TEST GUIDE (Section 703.4) for the recommended number of tests to be conducted. This is only a guide to the number of tests to be taken.

G. Cement

1. Job Control - A sample of the cement being used should be taken at the batch plant each day concrete is placed. This sample shall be properly tagged and submitted with a copy of the mill test report to the Bureau of Materials and Research. The cement sample is available should there be a problem with the 28-day concrete strength. The Bureau of Materials and Research arbitrarily chooses one of these samples for each class of concrete to perform the Blaine and cube tests.

H. Reinforcing Steel

1. Job Control - Samples of reinforcing steel shall be taken from each shipment. Select two sample bars at random for each bar size. Each sample bar should be cut to 24 inches (600 mm) long and should include the bar markings whenever possible. Two complete mechanical splices shall be sampled from the delivery to include both the male and female pieces when used on the project. Samples shall be sent to the Bureau of Materials and Research for verification of tensile strength before being used in the project. It is also required that the supplier furnish Certificates of Compliance with each shipment.

I. Asphalt Cutback and Emulsions

1. Job Control - The driver of each truck delivering liquid asphalt to the project must give the Contract Administrator a delivery slip from the transporting company as well as

a weight slip furnished to the transporting company by the refinery. The refinery or plant weight slip also serves as a Certificate of Compliance guaranteeing the quality of the load, provided that this is stated on the face of the slip.

A sample shall be taken from each load of asphalt delivered to the project. The Specifications require a sampling valve to be installed in all asphalt haulers. Allow a small quantity to escape from the valve before taking a one-quart (one-liter) sample. The first sample shall be sent to the Bureau of Materials and Research for testing. Subsequent samples shall be taken until five are collected. One of these five samples shall be selected at random and sent to the LAB. This procedure of testing one sample out of five shall be continued for the length of the project. The remaining four samples out of each group of five shall be retained on the project until the project is accepted.

If the first sample of any group does not meet Specifications, the LAB may request that the remaining four samples be submitted for testing.

J. Paints

The Contract Administrator shall be furnished with a Certificate of Compliance for all paint used for shop coats prior to or upon delivery of painted structural steel to the project. The Certificate of Compliance shall be accompanied by a certified analysis of the paint identified by the information given on the label on the paint container.

Paint furnished for field use shall not be applied until tested and accepted by the LAB. The Contract Administrator may permit application of the paint in a shorter time upon approval by the LAB of the manufacturer's Certificate of Compliance.

Send the Certificate of Compliance to the LAB for approval together with the information on the label, which should include:

a. New Hampshire (NH) paint number, name and color.

b. Lab and/or batch numbers.

c. Date of manufacture.

d. Volume of the contents in gallons (liters).

e. Name and address of manufacturer.

For testing at the laboratory, an unopened 5-gallon (18.9 L) original container shall be provided. The unused paint will be returned to the Contractor.

Pavement marking paint should be sampled from the striping truck in air tight quart cans. These paint cans may be obtained from the LAB. The paint used for pavement markings must be from a batch that has been previously tested and approved by the LAB. The list of acceptable batch numbers may be received from the Construction Office of the LAB.

K. Epoxy Coating

Samples are not required for testing; however, materials furnished should be listed on the Department's Qualified Products List. A Certificate of Compliance is also required.

L. High Strength Bolts

The Contract Administrator may submit bolts, nuts, and washers to the LAB for

hardness testing.

M. Neoprene Joint Materials

The Contract Administrator may submit a 6 inch (150 mm) sample, when deemed necessary, to the Bureau of Materials and Research for verification of the presence of chloroprene, which is the primary component of neoprene.

This sample should be taken as soon as the material is received on the project so that it can be tested before use. A Manufacturer's Certificate of Compliance is required.

N. Catch Basin and Slope Paving Blocks

Samples should be taken at the start of the project from each supplier and sent to the Bureau of Materials and Research. A Certificate of Compliance is also required.

703.3 – SUMMARY OF NHDOT METHODS FOR MATERIALS ACCEPTANCE

A. Acceptance by Sampling and Testing

1. Final Acceptance - Job Site
2. Preliminary Acceptance - Source Testing & Inspection
   a. Source testing such as L.A. Wear tests.
   b. Inspection of items such as concrete pipe and structural steel.

B. Acceptance by Certification

1. Certificate of Compliance only.
2. Qualified Products List and Certificate of Compliance, as required by Specifications.
3. Verification tests and Certificate of Compliance as defined by the TEST GUIDE.

C. Acceptance by Field Inspection

Granite, fieldstone, mulch and other natural materials not requiring testing or certification as designated by the District Construction Engineer will be accepted by field inspection.

703.4 – NHDOT GUIDE TO FREQUENCY OF SAMPLING AND TESTING

NHDOT GUIDE TO FREQUENCY OF SAMPLING AND TESTING (TEST GUIDE)

Item	Material & Test	Acceptance [5,9] Testing	Independent [5,8] Assurance Test	Verification Test	Source App./ Process Cont.
203	**Embankment** -Compaction	(I) 1/1,500 LF/lift (1 / 500 m / lift) [1]	(I) 1/50,000 cy (1 / 25,000 m^3) [1]		
209.1	**Granular Backfill** -Compaction -Gradation	(I) 2/abutment or substructure loc 1 / structure / source	(I) 1 / structure None		(S) Contractor [4]
304.1	**Sand** -Compaction -Gradation	(I) 1/1,500 LF/lift (1 / 500 m / lift) [1] 1/4,000 cy (1 / 3,000 m^3) [1,2]	(I) 1/5,000 LF/lift (1 / 1,500 m / lift) [1] 1 / 8 acceptance tests [1,2]		(S) Contractor [4]
304.2 304.3 304.4 304.5 304.6 306.1 306.2	**Processed Bases (Select Materials Itemized)** -Compaction -Gradation -Wear Test	(I) 1/1,500 LF/lift (1 / 500m / lift)[1,6] 1/4,000 cy (1 / 1,500 m^3)[1,2,3]	(I) 1/5,000 LF/lift (1 / 1,500 m / lift) [1,6] 1 / 8 acceptance tests [1,2,3]		(S) Contractor [4] 1 / source [7]

Note: / (slash) read as "per" (◯) - Location of sampling (see below)

Footnotes:

1. Or fraction thereof.
2. Gradation testing frequency may be reduced to one per 8000 cy (6000 m^3) if the minus #200 (0.75 mm) sieve content is less than 7% on the previous test (10% for crushed stone base course), based on the washed sample.
3. Partial gradation will still be performed to check for stone content at the frequency of one test per 4000 cy (3000 m^3).
4. Project personnel will assist the contractor to help ensure that sampling and testing procedures are correct.
5. On projects with 4000 cy (3000 m^3) or less of each select materials and embankment the acceptance testing will be done by Materials & Research Bureau (Lab) with no assurance testing required. The Contract Administrator is responsible for scheduling and ensuring the proper number of tests is performed.
6. No compaction test required for 304.5 and 304.6.
7. Sampled by project personnel & tested by the Lab.
8. Sampled & tested, observed, or inspected by the Lab, unless otherwise noted.
9. Sampled & tested by project personnel, unless otherwise noted.

Key for Sampling Locations:

Use the following code letters to indicate where tests were performed.

- I - Tested on in place material on project.
- S - Inspected at Contractor's source or point of manufacture.
- P - Project.
- A - Asphalt plant.
- C - Concrete plant.
- M - Submitted directly to the Bureau of Materials and Research from the manufacturer.

NHDOT TEST GUIDE (cont'd)

Item	Material & Test	Acceptance [8] Testing	Independent [8] Assurance Test	Verification [8] Test	Source [8] Approval
403 410 411 415 608 609	**Asphalt Cement** -Relevant AASHTO Test **Emulsified Asphalt** -Relevant AASHTO Test			(A) 2 / day [10,13] 2 / day [8,9,10,13]	(S) **Yearly Approvals** -asphalt plant -lab equip.
	Aggregates -Gradation (Hot Bin)	(A) 1 / day	(A) None		-lab control design mixes (diff. plant)
	Asphaltic Concrete -Gradation, Asphalt Content & Marshall (as noted) % Compaction	(A) 2 / mix / day [11,12] (I) 1/200 Tons (1 / 200 t) [9,15]	(A) 1/mix/7,000 T (1 / mix / 6,000 t)[11,12] (I) 2 cores/lane mile (2 cores / lane km) [14]		-commercial aggregate: 1 / yr. -project aggregate-one before use (relevant AASHTO test)
508	**Structural Fill** -Compaction -Gradation	(I) 1 / 2 lifts [9] 1 / structure/ source [9]	(I) 1 / structure None		

Note: / (slash) read as "per" ◯ - Location of sampling, see first page of TEST GUIDE

Footnotes:

8. Sampled & tested, observed, or inspected by the Lab, unless otherwise noted.
9. Sampled & tested by project personnel, unless otherwise noted.
10. Certificate of Compliance, Certified Bill of Lading or Mill Test Report required, as applicable.
11. Marshall test on wearing surface only.
12. None required for less than 100T (100 t); minimum 1 sample per project.
13. Sampled from tanker and or storage tank; one sample for back up testing.
14. Pavement overlay two cores per mile (kilometer) and minimum of 2 per project, (thickness, density, and % asphalt on 10% of cores). This is a guideline only and not required. Actual cores taken, if any, will be determined by the Lab.
15. Rate of testing for nuclear density gauge. Minimum two per project.

NHDOT TEST GUIDE (cont'd)

Item	Material & Test	Acceptance [9] Testing	Independent [8] Assurance Test	Verification Test	Source Approval
520 570 608 615 616	**Structural Concrete** -Cylinders -Air, Slump, W/C	(P) 2/200 cy (2 / 160 m^3) [16,17] min. 2 / pour For 1st/100 cy (1st/80m^3), 1/50cy (1/40 m^3) [16,18,19] After 100cy (80 m^3), 1/200cy (1 / 160 m^3) [16]	(P) 2 observed / class concrete/ structure [20] 1 test / class of concrete/structure [20]		(S) **Yearly Approvals** -concrete plant -transit mixer -lab equipment -design mixes for certain classes
	Fine & Coarse Aggregates -Gradation & FM -Moisture	(C) 1 / day [18] 1 / pour [22]	(C) 1 / class concrete [20]		-aggregate: gradation, L.A. Wear, coating, color, absorption
	Portland Cement -Blaine & Cubes			(C) 1 / class concrete [18] P.C. sample 1 /day [7,10]	-cement sample chemical analysis (certain brand names)
544	**Reinforcing Steel** -tensile strength & elongation			(P) 2 / size / shipment [21,10,7]	

Note: / (slash) read as "per" ◯ - Location of sampling, see first page of TEST GUIDE

Footnotes:

7. Sampled by project personnel & tested by LAB.
8. Sampled & tested, observed, or inspected by LAB, unless otherwise noted.
9. Sampled & tested by project personnel, unless otherwise noted.
10. Certificate of Compliance, Certified Bill of Lading or Mill Test Report required, as applicable. (Footnotes 11, 12, 13, 14, 15 are not applicable.)
16. Or fraction thereof.
17. Additional cylinders are necessary for early cylinder breaks; also, cylinders should be made from concrete being tested.
18. None required for less than 10 cy (10 m^3).
19. First load of concrete will be tested and each change in additives or mix design requires additional tests.
20. Required for each bridge deck.
21. A 24 inch (600 mm) long reinforcement bar is required.
22. There should be an additional test if the pour is over 200cy (160 m^3) or there is an observed change in the moisture of the aggregate.

NHDOT TEST GUIDE (cont'd)

Item	Material & Test	Acceptance Testing	Independent Assurance Test	Verification [7] Test	Source Approval
550	**Neoprene Joint Material** -Relevant AASHTO Tests **High Tensile Bolts** -Hardness Test **Preformed Bearing Pads** -Compression Test			(P) 1 / project [10,23] 3 / proj/supplier [10,24] 1 / project [10,25]	
550 556	**Paint** - Relevant AASHTO Tests Shop Paint Field Paint [27]			None (P) Field Sampled [10,7] unopened 5 gallon (5 liter) container (M) Manuf. Sampled [10,7] 1 quart (1 liter) required	
604	**C.B. Barrel Blocks** -Compression Test			(P) 2 / supplier / proj [10]	
641	**Loam** -PH, Organics & Gradation	(S) 1 / source / project [26]	None		

Note: / (slash) read as "per" ◯ - Location of sampling, see first page of TEST GUIDE

Footnotes:

7. Sampled by project personnel & tested by LAB. (Footnotes 8 and 9 are not applicable.)
10. Certificate of Compliance, Certified Bill of Lading or Mill Test Report required, as applicable. (Footnotes 11 through 22 are not applicable.)
23. Testing not required. Submit a 6 inch (150 mm) sample, when deemed necessary, for a spot check.
24. Bolts, nuts & washers may be submitted for testing.
25. One extra pad will be supplied to the project 14 days prior to erection of structural steel for testing by the Lab.
26. Visual acceptance of loam is okay for projects with less than 2500cy (2 000 m^3).
27. Paint must be supplied to the project 10 days before its anticipated use to allow time for testing, unless it has been pre-approved by the Lab. The label should include paint number, name, color, lab and/or batch number, date of manufacture, volume and name and address of manufacturer.

703.5 – GUIDE TO ACCEPTABLE DEVIATIONS

This Guide is to be used in the comparison of acceptance test results and independent assurance test results.

Sieve Analysis - All Items (A) #4 (4.75mm) sieve and larger (B) Smaller than #4 (4.75mm) sieve (Sand portion)	% Deviation ± 7% ± 3%
Compaction Testing All Items	± 4%
Bituminous Mix Extraction (A) #4 (4.75mm) sieve and larger (B) Smaller than #4 (4.75mm) sieve (Total sample) (C) Asphalt Content	± 5% ± 3% ± 0.6%
Portland Cement Concrete Air Content Density Slump	 ± 1.1% ± 2% ± 1” (25 mm)

SECTION 704 - STANDARD METHODS OF SAMPLING, TESTING, AND RECORDING TEST RESULTS

704.1 – SAMPLING OF AGGREGATES FOR GRADATION (AASHTO T 2)

There are three primary methods used to collect samples of aggregates for gradation tests: sampling from a conveyor belt, sampling from a stockpile, and sampling from an open-face pit.

1. Conveyor Belt - Remove three equal size samples from the belt at random locations. The belt must be stopped at each location before the sample is removed. Each sample should be taken from the entire cross section of the belt. Be sure all fines are collected off the conveyor belt and added to the sample. If necessary, use a brush to gather the fines. Combine the three samples to form one field sample.

2. Stockpile

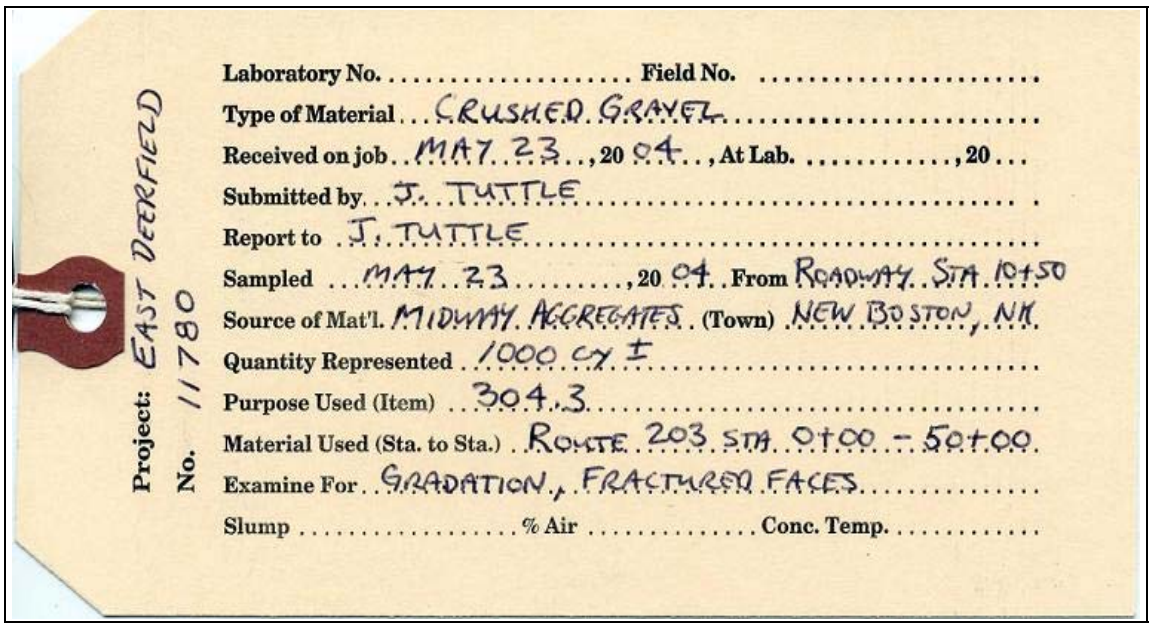
a. With Power Equipment - Have the power equipment (loader) remove material from different locations of the main pile. Mix this material into a small pile. Use the loader to level off this pile of mixed material before sampling it. Take several samples and combine them to form a field sample.

b. Without Power Equipment - Take samples from the top third, midpoint, and bottom third of the main pile. Inserting a board above the sampling location may help in stopping segregation. Combine the samples to form a field sample.

3. Open Pit Face - All sampling should be performed after all overburden has been removed. An area in the face should be channeled vertically from bottom to top. This blending should include all soil stratums. Testing is conducted on this blended material.

704.2 – TESTING FINE AND COARSE AGGREGATE FOR GRADATION (AASHTO T 27)

Obtain a representative sample as described above. This sample may be taken from a bank, a test pit or the roadway as required. Normally, a 40 to 50 pound (20 to 25 kg) sample is used. Fill out the front of a sample tag as follows:



Gradation Illustration - Assume for the purpose of illustration that a sample consists of a bag of 3 inch (75 mm) crushed gravel weighing 44 pounds (20 kg). Since the bag weighs about 0.4 pounds (0.20 kg), the net weight of the sample is 43.6 pounds (19.8 kg).

First, check the Specifications to see which sieve sizes are needed. For the crushed gravel, the necessary sizes are 3 inch, 2 inch, 1 inch and #4 (75 mm, 50 mm, 25.0 mm and 4.75 mm). It is acceptable to also use a ½ inch (12.5 mm) sieve to prevent overloading of the #4 (4.75 mm) sieve. AASHTO T 27 requires the total sample to be dried prior to the sieving process. Moisture in the sample can cause the fines in the sample to stick to the larger stone during sieving, which can cause inaccurate results in determining gradation percentages. Once the sample is dry, place it and the sieves in a shaker. Most field labs are equipped with a Gilson Mechanical Shaker for this purpose. If one is not available, this procedure may be done by hand using 18 inch diameter (450 mm) hand riddles. The sieve trays are placed in the Gilson shaker, in descending order, starting with the largest, or 3 inch (75 mm), sieve on top. Clamp the trays securely and shake the sample for a minimum of 7 minutes.

Loosen the trays and remove the various sizes of stone beginning with the 3 inch (75 mm) size. Weigh each size to the nearest 0.1 pounds (0.005 kilograms) in a container that has been weighed for its tare. Since the weights need to be cumulative to correctly determine the percentage of stone, weigh each size with the preceding size. Material passing the #4 (4.75 mm) sieve is considered the sand portion of the sample and is tested separately. The gradation percentages are calculated to the nearest tenth of a percent as in the following table.

Total weight of sample = 43.7 lbs (19.82 kg)

Sieve Size	Cum. Retained Wt. (less tare weight)	Percent Retained	Percent Passing Sieve	Specifications

3” (75 mm)	0 lbs (0 kg)	0 %	100 %	100
2” (50 mm)	0.7 lbs (0.32 kg)	1.6 %	98.4 %	95-100
1” (25 mm)	16.0 lbs (7.26 kg)	36.6 %	63.4 %	55-85
#4 (4.75 mm)	24.9 lbs (11.29 kg)	57.0 %	43.0 %	27-52
Passing	18.8 lbs (8.53 kg)	Check	Check	Check

In the case of gravel, it is only necessary to run the total sample through a #4 (4.75 mm) sieve, of which 25 to 70 percent shall pass. The sand portion should then be checked for the percent passing the #200 (0.075 mm) sieve according to the procedure described below.

1. Percent of Aggregate Passing the #200 (0.075 mm) Sieve (Wash Method) (AASHTO T 11) - The maximum amount of fine aggregate allowed to pass the #200 (0.075 mm) sieve is 12% as a percent of only the material passing the #4 (4.75 mm) sieve. To determine the percent passing the #200 (0.075 mm) sieve, thoroughly mix the sand portion of the sample and obtain a representative sample of about 500 grams by using a sample splitter or by quartering. Dry the sample on a hot plate, stirring frequently to prevent burning. After it has cooled, weigh the dry sample to the nearest gram. Place the sample in a deep pan, such as a bread pan, and add enough water to cover the sample. Stir this mixture with your fingers. Pour the silty water through a #200 (0.075 mm) sieve. Do not dump the whole sample on the sieve, just decant the silty water. Repeat this process until the water is fairly clear.

Next, wash any particles remaining on the #200 (0.075 mm) sieve back into the sample pan. A short piece of hose makes this much easier. Carefully pour off the excess water, being careful not to lose any material. Dry the sample on a hot plate, stirring to prevent boiling and burning. When the sample has cooled, shake it through the 8” (200 mm) diameter brass sieves. Use at least 4 sizes so no sieve is overloaded (Example: #10 (2.00 mm), #40 (0.425 mm), #100 (0.150 mm), and the #200 (0.075 mm)). Clamp the sieves in the shaker and shake for 10 minutes. Since only the percentage passing the #200 (0.075 mm) sieve into the bottom pan is needed, all sieve sizes may be weighed together to the nearest gram to determine the retained weight after washing and sieving.

$$\% \text{ Passing \#200 Sieve} = \frac{\left[\text{Original Sample Weight} - \text{Retained Weight after Washing and Sieving}\right]}{\text{Original Sample Weight}} \times 100$$

2. Determination of the Percent of Aggregate Passing the #200 (0.075 mm) Sieve (Dry Method) - The present Specifications for sand, gravel, and crushed gravel allow a maximum of 12% passing the #200 (0.075 mm) sieve based only on the material passing the #4 (4.75 mm) sieve. The standard LAB method consists of first washing the sand over a #200 (0.075 mm) sieve, drying it, and finally shaking it over a #200 (0.075 mm) sieve. Since this process is time consuming, the following field procedure may be used if the sample meets the following criteria:

If the percentage passing the #200 (0.075 mm) sieve is at least 5% below the required Specification by the washed method, the dry method may be used the next time if the material is the same. The dry method dispenses with washing through a #200 (0.075 mm) sieve and saves time by not having to dry the sample a second time. The original drying and shaking procedure remains the same. To complete a gradation by the dry method, dry the representative sample on a hot plate. Allow it to cool and shake it for 10 minutes through the nested sieves. Compute the percent passing the #200 (0.075 mm) sieve the same way as indicated in the example for the washed method.

The percent passing the #200 (0.075 mm) sieve calculated by this method will always be lower than by the washed method because some inefficiency of the sieves occurs with larger amounts of fine material. Washing the sample removes the majority of the minus #200 material (smaller than 0.075 mm) before the final screening. The difference between washed and dry sieving becomes greater as the silt content of the sample increases. Samples with less than 5% of the material passing the #200 (0.075 mm) sieve may increase by only 1% - 2% if washed, while samples with 10% of the material passing the #200 (0.075 mm) sieve may have an increase of 5% or more when calculated after washing. When the dry method is used, it should be stated on the field report.

Generally speaking, any select material's silt content will increase due to the process of trucking and constructing the base course. Although the amount of variance is dependent on the type of materials, this factor should be considered when testing from a stockpile. Silty samples are more prone to higher increases in material passing the #200 (0.075 mm) sieve.

The dry sieving test is not suitable for testing borrow which contains a high percentage of silt. For borrow with a high percentage of silt, the washed procedure must be used.

3. Percent of Fractured Faces in Crushed Gravel - The percentage of fractured faces in crushed gravel shall be determined by weight. This determination is made only on the portion of stone retained on and above the 1 inch (25.0 mm) sieve.

The total stone retained on and above the 1 inch (25.0 mm) sieve shall be weighed and the weight recorded. All stones showing a fractured face shall be removed and weighed together.

$$\% \text{ Fractured Faces} = \frac{\text{Lbs (kg) Fractured Stone on and above the 1" (25mm) Sieve}}{\text{Lbs (kg) Total Stone on and above the 1" (25 mm) Sieve}} \times 100$$

4. Los Angeles Abrasion (Wear) Test (AASHTO T 96)

a. Scope - Ideally, the sample should be obtained from the face of the pit after the face has been cleaned down and a quantity of fresh gravel representing the whole face is pulled down into a pile. This pile should be thoroughly mixed together before the sample is taken. If the pit varies considerably so that it is difficult to obtain one sample that represents the whole pit, more than one sample may be taken and identified as to the section of the pit where the sample was obtained.

b. Field Procedure - the sample is obtained by discarding any stone remaining on the 1 1/2" (37.5 mm) screen and retaining all the stone remaining on the #4 (4.75 mm) screen. Send a full bag of stone to the Bureau of Materials and Research for testing.

c. Laboratory Procedure - obtain an 11 pound sample (5 kg) of stone according to the table.

Sieve Size		Weight Retained Each Sieve
1" (25.0 mm)		2.75 lbs (1.25 kg)
3/4" (19.0 mm)		2.75 lbs (1.25 kg)
1/2" (12.5 mm)		2.75 lbs (1.25 kg)
3/8" (9.5 mm)		2.75 lbs (1.25 kg)
	Total Weight	11.00 lbs (5.00 kg)

Place the sample into the Los Angeles Drum with 12 steel balls and rotate for 500 revolutions. At the end of 500 revolutions, screen the stone through the #12 (1.70 mm) sieve and weigh the retained stone.

Computation:

$$\frac{(\text{Total Original Wt - Wt Retained}) \times 2}{100} = \%\ \text{Wear}$$

When all tests have been completed, enter all gradation and % fracture data on the back of the sample tag and on the Sieve Analysis worksheet. Also enter the results of the tests on the Construction Gradation Test Report sheets or the Testing Laboratory Report Sheets. Samples of these forms may be found on the following pages.

CSAWS
(Rev. 4/96)

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION
SIEVE ANALYSIS WORK SHEET

Date 06/29/05

Project Laconia Fed. No. NHS 018-2 (104) State No. 99999

Contractor Plow Brothers, Inc. Contract Administrator Ronald Tanner

Material Crushed Gravel Location to be used Sta. 70+00 - 73+20

Source Burton Pit Town Laconia

Item No. 304.3 Field Test No. 28

Total Weight 43.6 lb	GRADATION (Sample #1)				Total Weight	GRADATION (Sample #2)			
Sieve Size	Accum. Weight Retained	Percent Retained	Percent Passing	Required Spec.	Sieve Size	Accum. Weight Retained	Percent Retained	Percent Passing	Required Spec.
6"					150.0				
3"				100	90.0				
2"	0.7	1.6	98.4	95-100	75.0				
1 1/2"					50.0				
1"	16.0	36.6	63.4	55-85	37.5				
3/4"					25.0				
1/2"					19.0				
3/8"					4.75				
#4	24.9	57.0	43.0	27-52	0.075				
Fractured Faces	13.4/16.0 x 100 = 83.8%			50-100	Frac. Faces				

Total Weight 530.0 g	SAND OR MINUS 4.75 FRACTION				Total Weight	SAND OR MINUS 4.75 FRACTION			
Sieve Size	Accum. Weight Retained	Percent Retained	Percent Passing	Required Spec.	Sieve Size	Accum. Weight Retained	Percent Retained	Percent Passing	Required Spec.
3/8"			100		9.50				
#4	0.00		100	100	4.75				
#8					2.36				
#16					1.18				
#30					0.600				
#50					0.300				
#100	516	97.4	2.6		0.150				
F.M.					F.M.				
#200	520	98.1	1.9	0-12	0.075				

Remarks Informational Sample Only

Meets Requirements for Item 304.3 - Crushed Gravel Tested by Joe Merrow

(Rev 3/96)

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION
GRADATION TEST REPORT

Project Laconia Field Test No. 304.1-062905a
Type of Material Sand Reported June 29, 2005
Reported by Ronald Tanner Received by Lab
Report to: Project Files ☒ Lab ☒ Contractor Plow Bros., Inc. ☒
Sampled 6/29/05 At (town) Laconia
Source of Material Rodd Pit
Sample From In-Place Material Pit ☐ Roadway ☒ Sta 19+80
Quantity (Represented or Estimate) 1500 CY +/-
Purpose / Location Sand Rte 11 Eastbound Item No. 304.1
Tested for: Gradation ☒ FM ☐ % Moisture ☐ on June 29, 2005

Sieve (mm)	Coarse Aggregates and Gravels							
	Size / % Passing		Size / % Passing		Size / % Passing		Combined Results	Required Spec.
6" (150.0)								
3½" (90.0)								
3" (75.0)								
2½" (63.0)								
2" (50.0)								
1½" (37.5)								
1¼" (31.5)								
1" (25.0)								
3/4" (19.0)								
1/2" (12.5)								
3/8" (9.50)								
#4 (4.75)								
#8 (2.36)								
#16 (1.18)								
#50 (0.300)								
#200 (0.075) in Total								
% Fract'd Faces								
	Fine Aggregates and Sands							
#4 (4.75)	98.4		98.2					70-100
#8 (2.36)								
#16 (1.18)								
#30 (0.600)								
#50 (0.300)								
#100 (0.150)								
FM								
#200 (0.075) in Sand	4.4		4.2					0-12
% Moisture								

Project personnel are required to fill out a field test report on all field tests (record and informational). One copy should be retained on the project, one copy should be sent to the Lab upon request, and one copy should be given to the Contractor. The Contract Administrator's name should appear in the "reported by" line. This should be the rule for all samples submitted, either on samples reported from the laboratory or on the field test reports.

Remarks:
Meets requirements for: Sand - Item 304.1 See reverse ☐

Tested by: _____
Signature

State of New Hampshire Department of Transportation
Bureau of Materials and Research

Gravel Fine & Coarse (304.2)

Sample ID:	*AA07620*		
Project:	**ENFIELD**	***Federal No:***	STP-TE-BRZ-T-X-145(2)
Proj No:	10652	***Source:***	Pike Ind.
NH Lab No:	N/A	***Report***	Charles Flanders
Material:	Granular Backfill	***Submittal***	4/17/2003 12:33:00
Sampled from:	200+62 RT SM	***Sample***	4/15/2003
Lot #:		***Sampled by:***	E. WELCH, & KC
Purpose:	209.2 Granular Backfill		

Analysis Validated JA ***Date:*** 4/21/2005 ***Sample Validated*** ADP ***Date:*** 4/21/2005

Remarks:

METHOD	*ANALYSIS*	*RESULT*	*UNIT*	*MIN*	*MAX*	*VIOLATIONS*
T27	6 in (150 mm) Sieve	100.0	% Passing	100		
T27	3 in (75 mm) Sieve	100.0	% Passing			
T27	2 in (50 mm) Sieve	92.8	% Passing			
T27	1 1/2 in (37.5 mm) Sieve	89.3	% Passing			
T27	1 in (25 mm) Sieve	82.5	% Passing			
T27	3/4 in (19 mm) Sieve	77.4	% Passing			
T27	1/2 in (12.5 mm) Sieve	72.9	% Passing			
T27	#4 (4.75 mm) Sieve	58.3	% Passing	25	70	
T27	No 10 (2.00 mm) Sieve	73.5	% Passing			
T27	No 20 (0.850 mm) Sieve	41.9	% Passing			
T27	No 40 (0.425 mm) Sieve	20.7	% Passing			
T27	#100 (0.150 mm) Sieve	2.6	% Passing			
T11	#200 (0.075 mm) Sieve	1.1	% Passing	0	12	
	Tested By:	RD				

Comments: See LIMS Report # aa07619 for AASHTO T96-A %LA Wear Test = 30.4%.

Thursday, April 21, 2005

NHDOT S1

TEST METHOD FOR DETERMINING THE AMOUNT OF MATERIAL FINER THAN THE NO. 200 SIEVE IN MINERAL AGGREGATES COMBINED WITH BITUMINOUS CONCRETE

1. Following AASHTO T 27, obtain an original sample weight for gradation. Sample may be air dried prior to sieving if excessively wet - DO NOT OVEN DRY. Grade the moist sample through the applicable large sieves (plus # 4). Immediately after sieving, remove all the lumps of bituminous concrete retained on the 3/4" and larger sieves and record their weight. Subtract this weight from the original sample weight. This reduced sample weight will be used to calculate the % passing for the sample's gradation.

2. Obtain two representative samples of the sand portion (minus #4). One sample will be used for the % moisture determination, per AASHTO T 265. The other sample will be used for a gradation test. Record the WET weight for the gradation test sample, DO NOT DRY.

3. Proceed with AASHTO T 265, % moisture determination of the sample's sand portion.

Percent Moisture of Sand Portion

$$P = \frac{100(W-D)}{D}$$

P = % moisture content of sand portion
W= Original wet weight of moisture determination sample
D = Dry weight of moisture determination sample

4. The non-dried sand portion of the test sample will be washed in accordance with AASHTO T 11, with the exception that no dry weight will be obtained. This washed gradation sample will be oven dried before shaking in the 8" nesting sieves. After drying, proceed with the gradation per T 11.

5. With the calculated % moisture from the moisture determination sample (refer to steps 2 and 3), reduce the wet weight of the sample's sand gradation test portion by this moisture percentage. Use this calculated dry weight to determine the % passing the # 200 sieve.

Calculated Dry Weight

$$C = w - \left[\left(\frac{P}{100} \right) w \right]$$

C = Calculated dry weight of sand portion

P = % moisture of sand portion (see step 3)

w = Recorded wet weight of sand portion (see step 2)

704.3 – TESTING SOIL FOR MOISTURE-DENSITY RELATIONS (PROCTOR) (AASHTO T 99)

A. Method A

1. Sample - If the soil sample is damp when received from the field, dry it until it becomes friable under a trowel. The sample may be air-dried or a drying apparatus may be used, provided that the temperature of the sample does not exceed 140°F (60 °C). When the sample is dry, thoroughly break up the lumps in such a manner as to avoid reducing the natural size of individual particles. Sieve an adequate quantity of the representative soil over the #4 (4.75 mm) sieve. Discard the coarse material, if any, retained on and above the #4 (4.75 mm) sieve. From the soil that passed the #4 (4.75 mm) sieve, select a representative sample weighing approximately 11 pounds (500 grams).

2. Procedure - Thoroughly mix the selected representative sample with sufficient water to dampen it to approximately four percentage points below optimum moisture content. Weigh the mold and the base plate (without the extension collar) and record to the nearest 0.01 lbs (5 grams). Form a specimen by compacting the prepared soil in the 4-inch (100 mm) mold (with the collar attached) in three equal layers to give a total compacted depth of about 5" (125 mm). Compact each layer by 25 uniformly distributed blows from the 5.5 lb (2.5 kg) hammer, dropped free from a height of 12" (300 mm). During compaction, the mold should rest on a uniform, rigid base.

Following compaction, remove the extension collar and carefully trim the compacted soil level with the top of the mold by means of a straightedge. Holes developed in the surface caused by the trimming shall be patched with the smaller sized material that was struck off. Weigh the mold and material; multiply the weight of the compacted specimen minus the weight of the mold by 30 (1060) and record the result as the wet density in pounds per cubic foot (kilograms per cubic meter) of the compacted soil.

Remove the material from the mold and slice it vertically through the center. Take a representative sample of the material from one of the cut faces, weigh it immediately and dry it to a constant weight. The moisture content sample shall not weigh less than 250 grams. (You may use a "Speedy" moisture tester.)

Thoroughly break up the remainder of the material until it will pass a #4 (4.75 mm) sieve, as judged by eye. Add water in sufficient amounts (100 ml if you started with 500 grams) to increase the moisture content of the soil sample by two percentage points, and repeat the above procedure for each increment of water added. Continue this series of determinations until there is either a decrease or no change in the wet density of the compacted soil. This happens when water, lighter than soil, displaces the soil in the mold. The water will frequently leak from the base of the mold at this point. Your moisture sample should be obtained from the pan after the sample leaks.

The above procedure has been found to be satisfactory in most cases. However, in instances where the soil is a heavy-textured, clay material into which it is difficult to incorporate water, a separate and new sample shall be used in each trial compaction test. In these cases, separate samples shall be thoroughly mixed with amounts of water sufficient to cause the moisture contents of the samples to vary by approximately two percentage points. The moistened soil thus provides samples which, when compacted, will increase in weight to the

maximum density and then decrease in weight. The samples of soil-water mixtures shall be placed in covered containers and allowed to stand for not less than 12 hours before making the moisture-density test.

3. Calculations - Calculate the moisture content and the dry weight of the soil compacted for each trial as follows:

$$M = \frac{A - B}{B - C} \times 100$$

and

$$W = \frac{W_1}{M + 100} \times 100$$

where,

M = percentage of moisture in the specimen, based on dry weight of soil.

A = weight of the container and wet soil

B = weight of the container and dry soil

C = weight of the container

W = dry density in pounds per cubic foot (kilograms per cubic meter) of compacted soil, and

W_1 = wet density in pounds per cubic foot (kilograms per cubic meter) of compacted soil.

4. Moisture-Density Relationship - The calculations above shall be made to determine the moisture content and corresponding dry density for each of the compacted soil samples. The dry density of the soil shall be plotted on the y-axis of a graph, and the corresponding moisture contents shall be plotted on the x-axis (see the graph at the end of this Section).

5. Optimum Moisture Content/Maximum Density - When the densities and corresponding moisture contents for the soil have been determined and plotted, it will be found that by connecting the plotted points with a smooth line, a curve is produced. Select the peak of the curve and record the moisture and dry density found at this point. This is the optimum moisture and maximum dry density with which to compare the field density.

Proctor Maximum Dry Density (English)

Date 06/29/05

Project (town) Laconia Fed. No. NHS-018-2 (104) State No. 99999

Contractor Plow Brothers Contract Administrator R. Tanner

Source of Material Crystal Street Soil Type Fine Silt

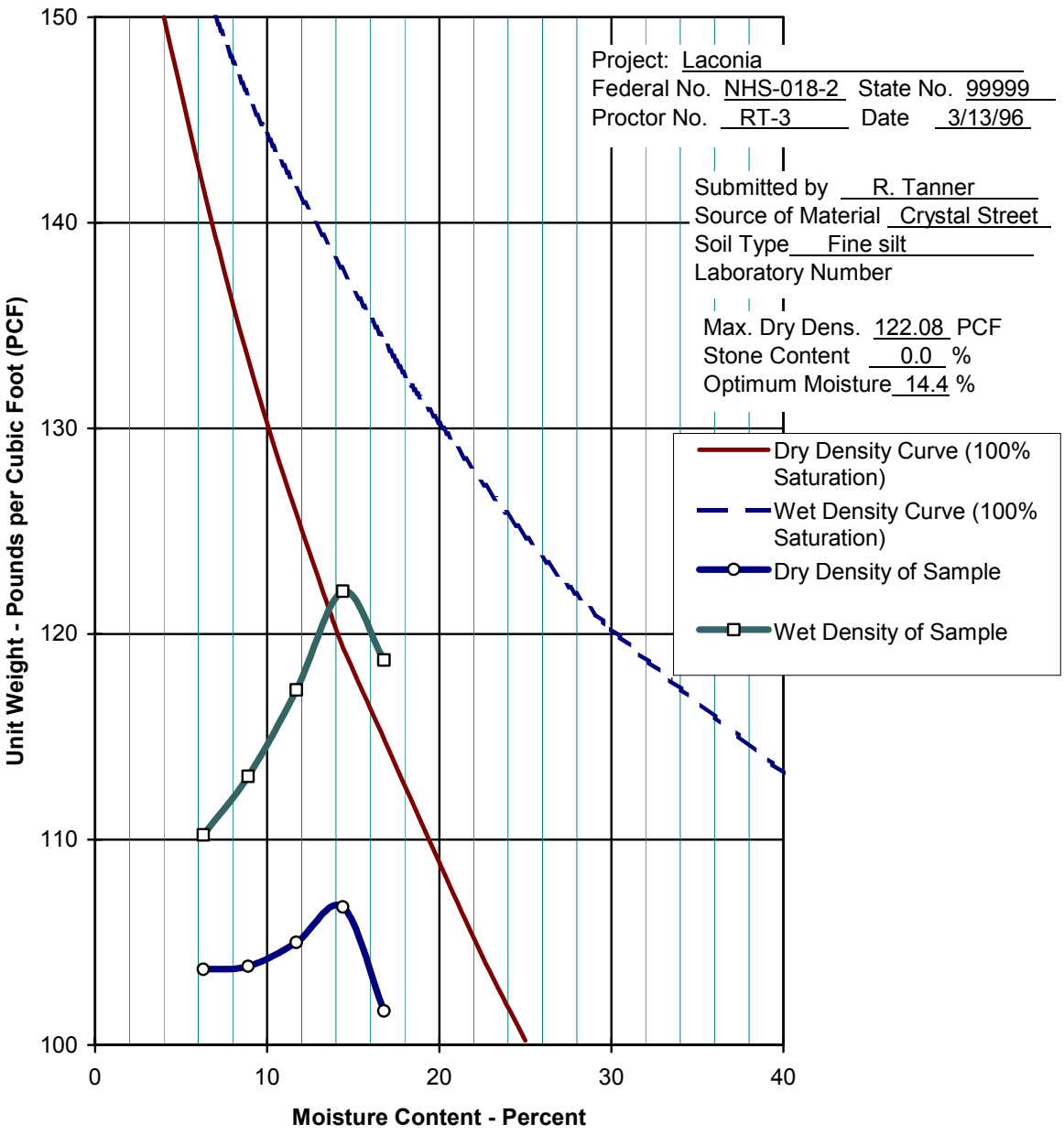
Proctor Number RT-3 Location to be Used Plummer Rd.

Lab Number Field No. 3

A. Wt. Mold + Wet Soil (lbs)	13.07	13.17	13.31	13.47	13.36
B. Wt. Mold (lbs)	9.40	9.40	9.40	9.40	9.40
C. Wt. Wet Soil (A-B)	3.67	3.77	3.91	4.07	3.96
D. Wet Density (C x 30)	110.22	113.08	117.27	122.08	118.73
E. Moisture Container No.	1	2	3	4	5
F. Wet. Wt. + Tare (g)	303.7	248.8	209.4	228.4	256.7
G. Dry Wt. + Tare (g)	290.9	232.33	192.4	205.9	230.1
H. Tare Wt. (g)	88.3	47.8	46.3	49.1	72.1
I. Wt. of Water (F-G)	12.8	16.4	17.1	22.5	26.6
J. Wt. of Dry Soil (G-H)	202.6	185.2	146.1	156.8	158.0
K. % Moisture [(I/J) x 100]	6.3	8.9	11.7	14.4	16.8
L. Dry Density [(D x 100)/(100+K)]	103.69	103.84	104.99	106.71	101.65

Max. Wet Density	122.08	PCF
Max. Dry Density	106.71	PCF
Optimum Moisture	14.4	%
#4 Stone retained	0.0	%

Optimum Moisture - Maximum Density Curve (English)



Proctor Maximum Dry Density (Metric)

Date 06/29/05

Project (town) Laconia Fed. No. NHS-018-2 (104) State No. 99999

Contractor Plow Brothers Contract Administrator R. Tanner

Source of Material Crystal Street Soil Type Fine Silt

Proctor Number RT-3 Location to be Used Plummer Rd.

Lab Number Field No. 3

A. Wt. Mold + Wet Soil	5.92	5.97	6.03	6.10	6.06
B. Wt. Mold	4.26	4.26	4.26	4.26	4.26
C. Wt. Wet Soil (A-B)	1.66	1.71	1.77	1.84	1.79
D. Wet Density (kg/m^3)	1762.1	1806.9	1874.2	1951.0	1898.2
E. Moisture Container No.	1	2	3	4	5
F. Wet. Wt. + Tare	303.7	248.8	209.4	228.4	256.7
G. Dry Wt. + Tare	290.9	232.33	192.4	205.9	230.1
H. Tare Wt.	88.3	47.8	46.3	49.1	72.1
I. Wt. of Water (F-G)	12.8	16.4	17.1	22.5	26.6
J. Wt. of Dry Soil (G-H)	202.6	185.2	146.1	156.8	158.0
K. % Moisture [(I/J) x 100]	6.3	8.9	11.7	14.4	16.8
L. Dry Density (kg/m^3) [(D x 100)/(100+K)]	1657.5	1659.8	1678.3	1705.8	1624.8

Max. Wet Density	1951.0	kg/m^3
Max. Dry Density	1705.8	kg/m^3
Optimum Moisture	14.4	%
4.75 mm Stone retained	0.0	%

Optimum Moisture - Maximum Density Curve (Metric)

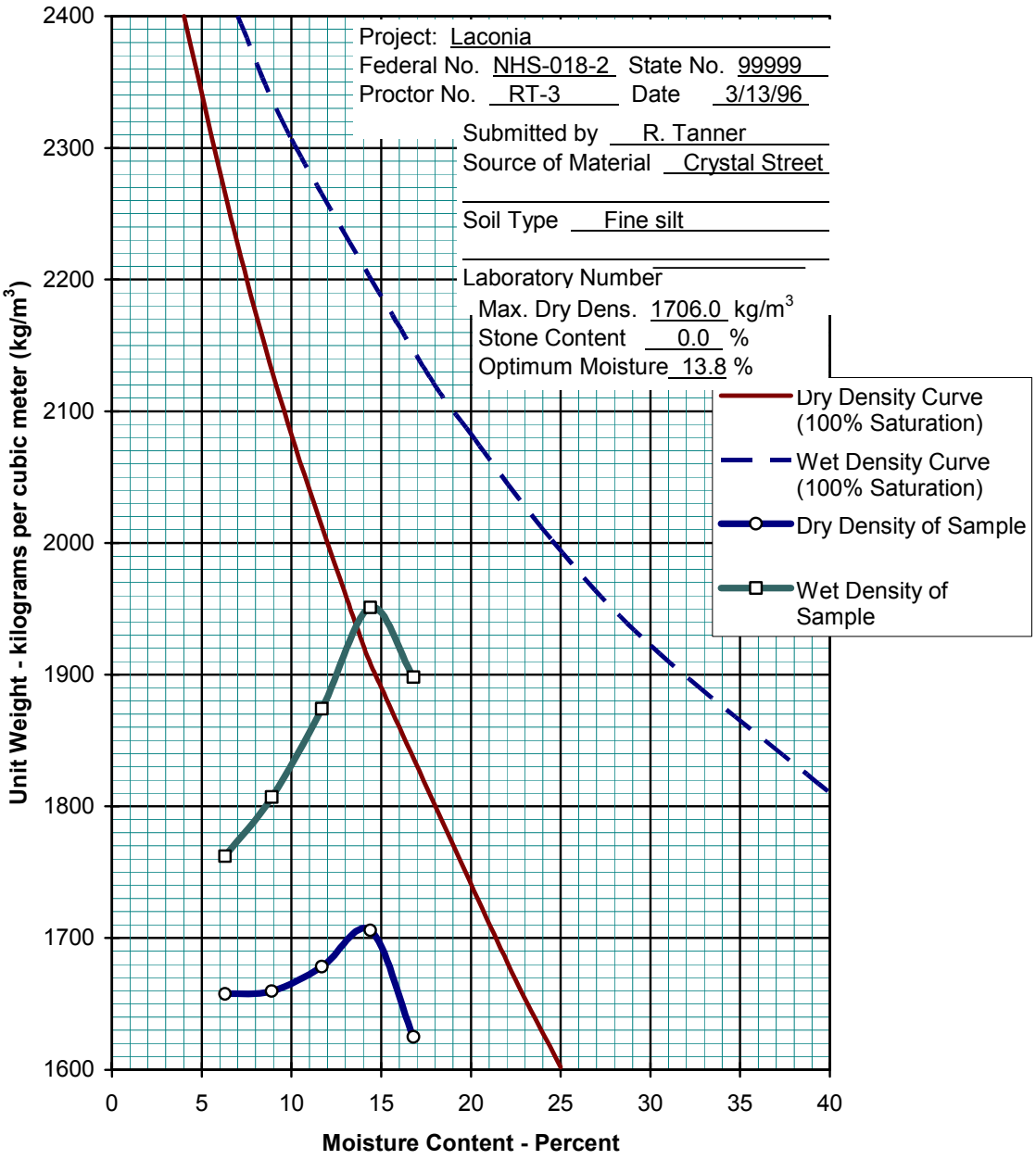
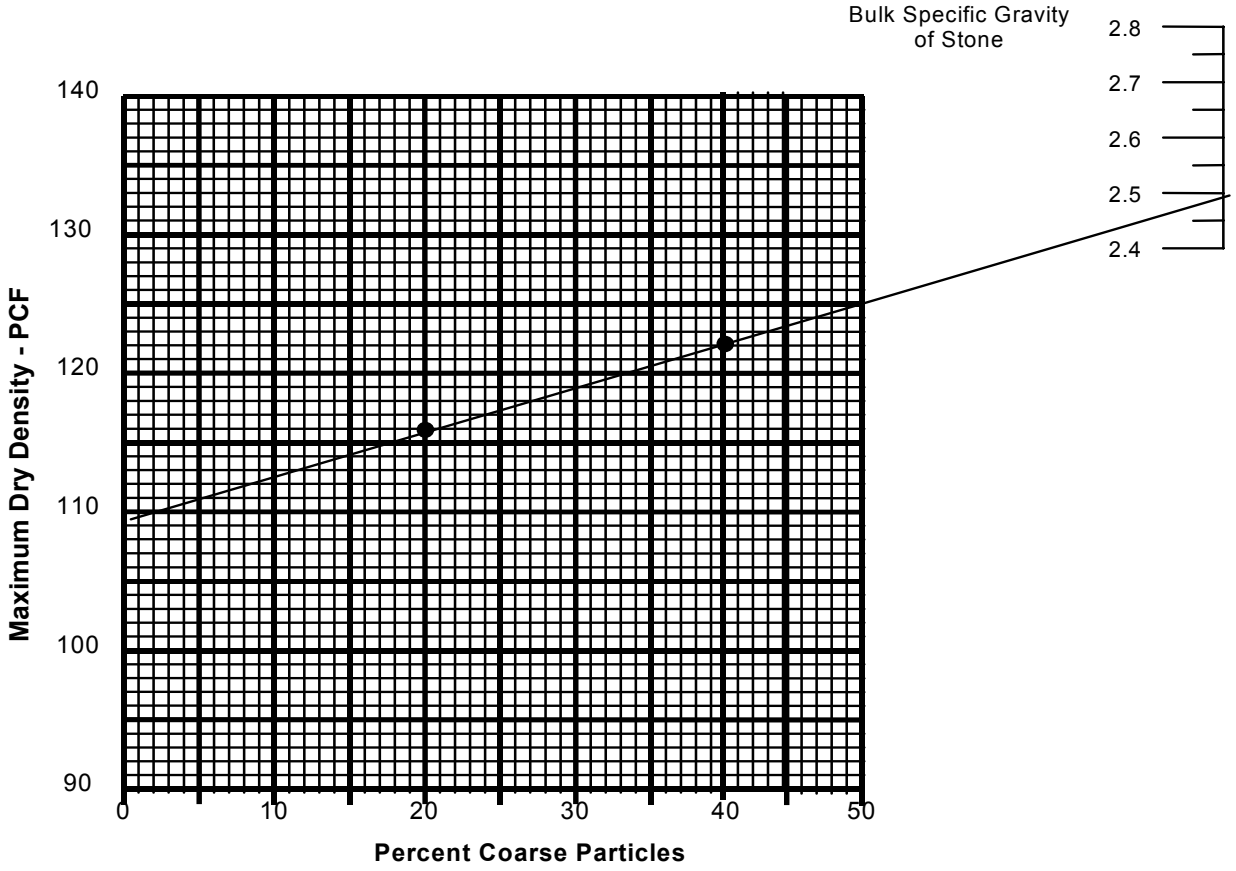


Figure 1: Sample Proctor Curve

704.4 – STANDARD METHOD OF CORRECTION FOR COARSE PARTICLES IN THE SOIL COMPACTION TEST (AASHTO T 224)

1. Scope - This method describes a procedure whereby the maximum soil density determined by AASHTO T 99 may be adjusted to compensate for differing percentages of coarse particles retained on the #4 (4.75 mm) sieve in the in-place density test.

Outline of Method - When Method A of AASHTO T 99 is employed, the maximum density shall be determined on the soil fraction passing the #4 (4.75 mm) sieve. The percentage of coarse particles above the #4 (4.75 mm) sieve in the in-place sample being tested shall be determined. An adjusted value for the maximum density of the in-place material can then be obtained by entering the determined percentage onto the "Density Correction Chart for Difference in Stone Content" as shown in the following example.



Example

Given:

Percent of stone larger than the #4 sieve in a Field Density Sample:	20%
Bulk Specific Gravity of Stone:	2.5
Maximum Dry Density from AASHTO T 99 Proctor Test:	109.5 PCF

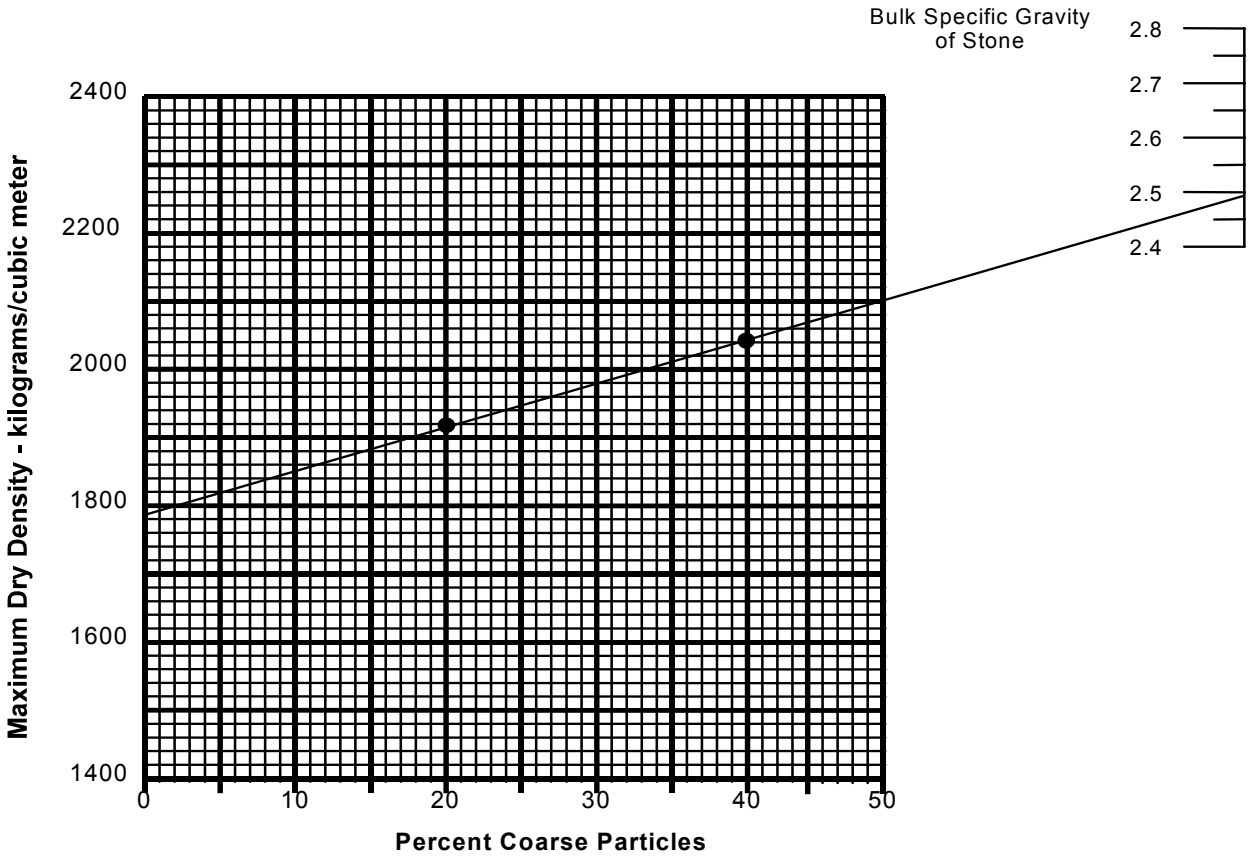
Procedure:

1. On the grid, locate the point on the left axis 109.5 PCF dry density at 0% stone.
2. Draw a line from the specific gravity of 2.5 to this point
3. Follow vertically from the 20% stone found in the field density sample to where it intersects this line.
4. Project horizontally to the dry density scale to find the corrected dry density to be 115.8 PCF.

Percent Compaction:

The in-place density of the material tested in the field is divided by this corrected density to find the percent compaction and then compared to the required specification.

Sample Density Correction Chart for Differences in Stone Content (English)



Example

Given:

Percent of stone larger than 4.75 mm in a Field Density Sample:	20%
Bulk Specific Gravity of Stone:	2.5
Maximum Dry Density from AASHTO T 99 Proctor Test:	1790 kg/m^3

Procedure:

1. On the grid, locate the point on the left axis 1790 kg/m^3 dry density at 0% stone.
2. Draw a line from the specific gravity of 2.5 to this point
3. Follow vertically from the 20% stone found in the field density sample to where it intersects this line.
4. Project horizontally to the dry density scale to find the corrected dry density to be 1915 kg/m^3.

Percent Compaction:

The in-place density of the material tested in the field is divided by this corrected density to find the percent compaction and then compared to the required specification.

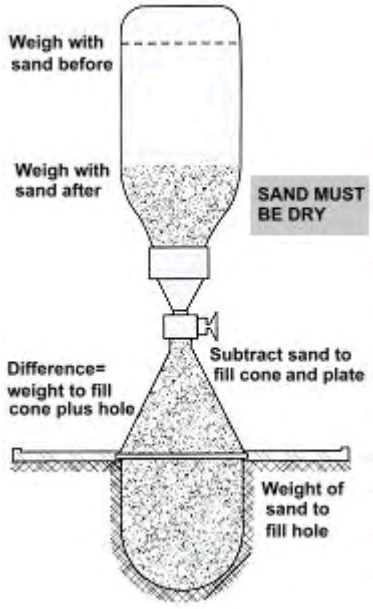
Sample Density Correction Chart for Differences in Stone Content (Metric)

704.5 – DENSITY OF SOIL IN-PLACE BY THE SAND CONE METHOD (AASHTO T 191)]

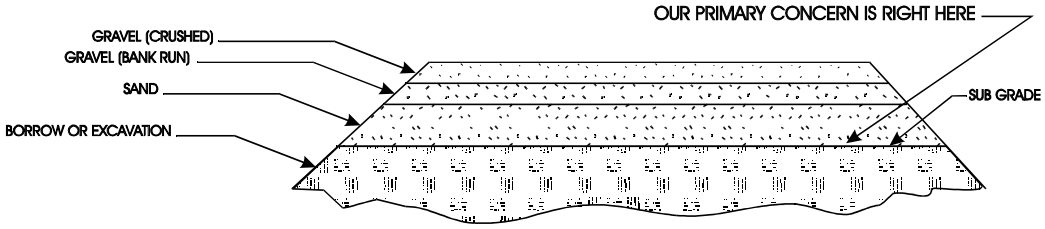
1. Scope - This method of test is intended for determining the in-place density of soils. The apparatus used is restricted to tests in soils containing particles not larger than 2" (50 mm) in diameter.

2. Density Apparatus - The density apparatus consists of a one gallon (4 L) jar, a detachable cone with a cylindrical valve for controlling the flow of calibrated sand, and a flat, rigid base plate upon which to set the cone.

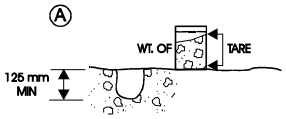
As field personnel rarely perform this test, please refer to the AASHTO T 191 test for a detailed description and procedure. A pictorial overview, sample report and moisture/stone content chart follow.



Field Density Test (Sand Cone Method)

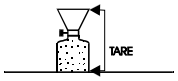


Ⓐ



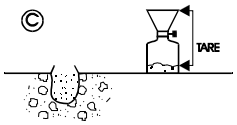
WT. OF SOIL REMOVED =
WT. OF SOIL & TARE - TARE

Ⓑ



ORIGINAL WT. OF SAND & TARE

Ⓒ



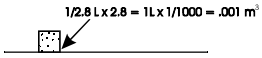
WT. OF SAND REMAINING & TARE

Ⓓ

WT. OF TEST SAND IN HOLE
& CONE (B - C)

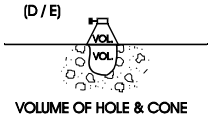
(PERFORMED IN LAB PRIOR TO TAKING THE TEST)

Ⓔ



UNIT WT. OF TEST SAND (kg / m³)

Ⓕ (D / E)



VOLUME OF HOLE & CONE

(DETERMINED IN LAB PRIOR TO TAKING THE TEST)

Ⓖ

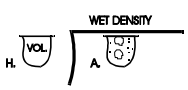
VOLUME OF CONE

Ⓗ

F - G

VOLUME OF HOLE

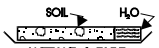
Ⓘ



(A / H) WET DENSITY (kg / m³)

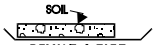
Ⓙ MOISTURE CAN NUMBER

Ⓚ



WET WT. & TARE

Ⓛ



DRY WT. & TARE

Ⓜ

TARE WEIGHT

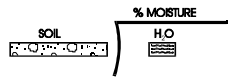
Ⓝ

WT. OF H₂O (K - L)

Ⓞ

WT. OF DRY SOIL (L - M)

Ⓟ



% MOISTURE - SAND PORTION
[(N / O) x (100)]

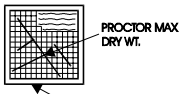
Ⓠ

CORR. % MOISTURE - TOTAL SAMPLE

Ⓡ $\frac{I}{100 + Q} \times 100 = \text{DRY DENSITY}$

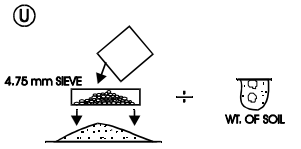
DRY DENSITY (kg / m³)

Ⓢ



Ⓣ PROCTOR OPT. MOISTURE

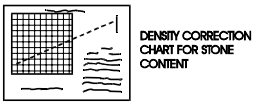
Ⓤ



STONE RETAINED ON 4.75 mm SIEVE DIVIDED BY WT.
OF ENTIRE AMOUNT OF SOIL REMOVED

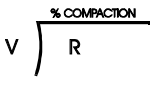
% STONE LARGER THAN 4.75 mm RETAINED

Ⓥ



CORRECTED PROCTOR MAX. DRY DENSITY.

(R / V)



% COMPACTION

Field Density Test (Sand Cone Method)

FIELD DENSITY TEST REPORT (SAND CONE METHOD) - ENGLISH

Date 2/7/96

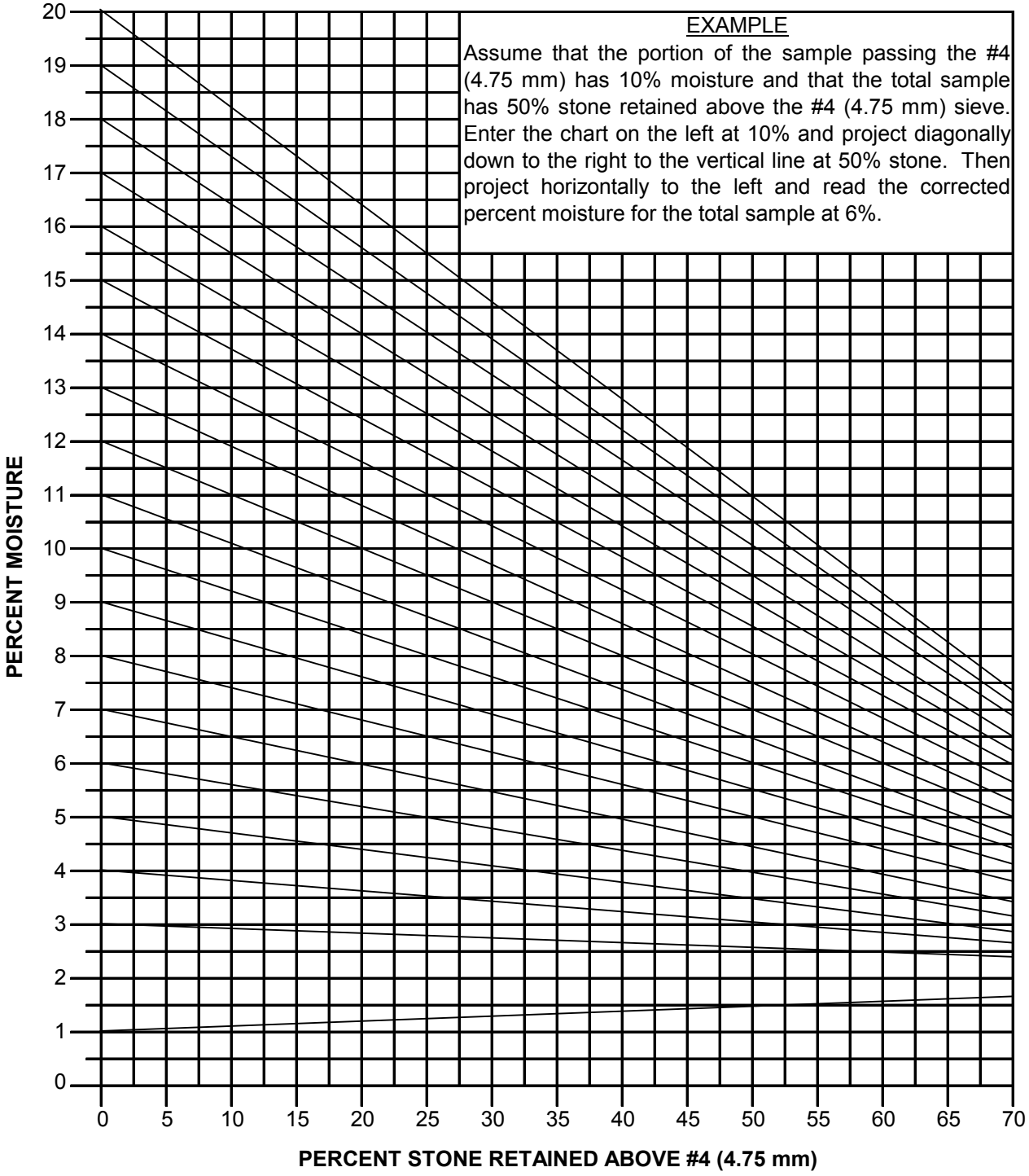
Project (Town) Laconia Fed. No. NHS-018-2 (104) State No. 99999

Contractor Plow Brothers, Inc. Contract Administrator Ronald Tanner

Lab. Number 106-68 Field No. 4

Station Number	123+50	136+00		
Test Location	Lt. 20’	Rt. 10’		
Source of Material (Pit)	230 - 240	230 - 240		
Type of Material	Silty Sand	Silty Sand		
Distance to Sub Grade	12’	14’		
Present Height of Fill	16’	8’		
A. Weight of Soil Removed – Tare (lbs)	5.90	6.98		
B. Original Weight of Sand + Tare (lbs)	15.94	15.96		
C. Weight of Sand Remaining + Tare (lbs)	7.64	6.89		
D. Weight of Sand in Hole & Cone (B-C) (lbs)	8.30	9.07		
E. Unit Weight of Test Sand (pcf)	96.22	96.22		
F. Total Volume of Hole + Cone (D/E) (ft^3)	0.0862	0.0943		
G. Volume of Cone (ft^3)	0.0395	0.0395		
H. Volume of Hole (F-G) (ft^3)	0.0467	0.0548		
I. Wet Density (A/H) (pcf)	126.34	127.37		
J. Moisture Can Number	8	10		
K. Wet Weight + Tare (g)	556.5	548.6		
L. Dry Weight + Tare (g)	521.2	523.7		
M. Tare Weight (g)	104.6	104.4		
N. Weight of Water (K-L) (g)	35.3	24.9		
O. Weight of Dry Soil (L-M) (g)	416.6	419.3		
P. Percent Moisture Sand Port. [(N/O) x (100)]	8.5	5.9		
Q. Corr. % Moisture Total Sample (from chart)	7.4	5.1		
R. Dry Density [(I/(100 + Q)) x (100)] (pcf)	117.6	121.2		
S. Proctor Max. Dry Density (pcf)	115.4	115.4		
T. Proctor Opt. Moisture (%)	8.8	8.8		
U. % Stone Larger than #4 Retained	15.8	20.3		
V. Corr. Proctor Max. Dry Density (pcf)	120.4	122.0		
W. Percent Compaction [(R/V) x 100]	97.7	99.3		
Proctor Curve Number Used	RT-7	RT-7		

MOISTURE CORRECTION CHART



FIELD DENSITY TEST (SAND CONE METHOD) - METRIC

Date 2/7/96

Project (Town) Laconia Fed. No. NHS-018-2 (104) State No. 99999

Contractor Plow Brothers, Inc. Contract Administrator Ronald Tanner

Lab. Number 106-68 Field No. 4

Station Number	86+40	88+20		
Test Location	Lt. 6 m	Rt. 3 m		
Source of Material (Pit)	230 - 240	230 - 240		
Type of Material	Silty Sand	Silty Sand		
Distance to Sub Grade	3.7 m	4.3 m		
Present Height of Fill	4.9 m	2.4 m		
A. Weight of Soil Removed – Tare (kg)	2.67	3.16		
B. Original Weight of Sand + Tare (kg)	7.22	7.23		
C. Weight of Sand Remaining + Tare (kg)	3.46	3.12		
D. Weight of Sand in Hole & Cone (B-C) (kg)	3.76	4.11		
E. Unit Weight of Test Sand (kg/m^3)	1538	1538		
F. Total Volume of Hole + Cone (D/E) (m^3)	0.002445	0.002672		
G. Volume of Cone (m^3)	0.001121	0.001121		
H. Volume of Hole (F-G) (m^3)	0.001324	0.001551		
I. Wet Density (A/H) (kg/m^3)	2016.6	2037.4		
J. Moisture Can Number	8	10		
K. Wet Weight + Tare (g)	556.5	548.6		
L. Dry Weight + Tare (g)	521.2	523.7		
M. Tare Weight (g)	104.6	104.4		
N. Weight of Water (K-L) (g)	35.3	24.9		
O. Weight of Dry Soil (L-M) (g)	416.6	419.3		
P. Percent Moisture Sand Port. [(N/O) x (100)]	8.5	5.9		
Q. Corr. % Moisture Total Sample (from chart)	7.4	5.1		
R. Dry Density [(I/(100 + Q)) x (100)] (kg/m^3)	1877.7	1938.5		
S. Proctor Max. Dry Density (kg/m^3)	1844.6	1844.6		
T. Proctor Opt. Moisture (%)	8.8	8.8		
U. % Stone Larger than 4.75 mm Retained	15.8	20.3		
V. Corr. Proctor Max. Dry Density (kg/m^3)	1923.8	1952.7		
W. Percent Compaction [(R/V) x 100]	97.6	99.3		
Proctor Curve Number Used	RT-7	RT-7		

704.6 – DENSITY OF SOIL IN-PLACE BY THE DRIVE CYLINDER METHOD (AASHTO T 204)

1. Scope - The drive cylinder method may be used in place of the sand cone method on those soils containing no stones.

2. Apparatus - A volume calibrated steel cylinder similar to a short section of a Shelby sampling tube with a machined cutting edge on one end.

A machined steel driving head and cap.

A driving hammer similar to a Marshall hammer.

Shovel, containers, scales, drying apparatus, straightedge, and knife.

As field personnel rarely perform this test, please refer to the above referenced AASHTO T 204 test for a detailed description and procedure. A sample report follows.

FIELD DENSITY TEST (DRIVE CYLINDER METHOD) - ENGLISH

Date 2/6/96

Project (Town) Laconia Fed. No. NHS-018-2 (104) State No. 99999

Contractor Plow Brothers, Inc. Contract Administrator Ronald Tanner

Lab. Number 104-68 Field No. 5

Station Number	123+00		130+50	
Test Location	Lt. 10’		Rt. 7’	
Source of Material	Ford		Ford	
Type of Material	Sand		Sand	
Distance to Sub Grade	14’		15’	
Present Height of Fill	10’		9’	
A. Mold Number	3		3	
B. Weight of Mold + Soil (lbs)	3.38		3.40	
C. Weight of Mold (lbs)	0.82		0.82	
D. Weight of Soil Removed (B-C) (lbs)	2.56		2.58	
E. Volume of Mold (ft^3)	0.021		0.021	
F. Wet Density (D/E) (pcf)	121.9		122.9	
G. Moisture Can Number	6		8	
H. Wet Weight + Tare (g)	547.4		519.1	
I. Dry Weight + Tare (g)	517.1		495.5	
J. Tare Weight (g)	104.5		105.6	
K. Weight of Water (H-I) (g)	30.3		23.6	
L. Weight of Dry Soil (I-J) (kg)	412.6		389.9	
M. Percent Moisture [(K/L) x (100)]	7.3		6.1	
N. Dry Density [(F/(100 + M)) x 100] (pcf)	113.6		115.8	
O. Proctor Max. Dry Density (pcf)	115.4		115.4	
P. Proctor Opt. Moisture (%)	8.8		8.8	
Q. Percent Compaction [(N/O) x 100]	98.4		100+	
Proctor Curve Number Used	RT-6		RT-6	

FIELD DENSITY TEST (DRIVE CYLINDER METHOD) - METRIC

Date 2/6/96

Project (Town) Laconia Fed. No. NHS-018-2 (104) State No. 99999

Contractor Plow Brothers, Inc. Contract Administrator Ronald Tanner

Lab. Number 104-68 Field No. 5

Station Number	71+20		30+50	
Test Location	Lt. 20 m		Lt. 3 m	
Source of Material	Ford		Ford	
Type of Material	Sand		Sand	
Distance to Sub Grade	4 m		4.5 m	
Present Height of Fill	9 m		7.5 m	
A. Mold Number	3		3	
B. Weight of Mold + Soil (kg)	1.53		1.54	
C. Weight of Mold (kg)	0.37		0.37	
D. Weight of Soil Removed (B-C) (kg)	1.16		1.17	
E. Volume of Mold (m^3)	0.000595		0.000595	
F. Wet Density (D/E) (kg/m^3)	1949.6		1966.4	
G. Moisture Can Number	6		8	
H. Wet Weight + Tare (g)	547.4		519.1	
I. Dry Weight + Tare (g)	517.1		495.5	
J. Tare Weight (g)	104.5		105.6	
K. Weight of Water (H-I) (g)	30.3		23.6	
L. Weight of Dry Soil (I-J) (kg)	412.6		389.9	
M. Percent Moisture [(K/L) x (100)]	7.3		6.1	
N. Dry Density [(F/(100 + M)) x 100] (kg/m^3)	1817.0		1853.3	
O. Proctor Max. Dry Density (kg/m^3)	1844.6		1844.6	
P. Proctor Opt. Moisture (%)	8.8		8.8	
Q. Percent Compaction [(N/O) x 100]	98.5		100+	
Proctor Curve Number Used	RT-6		RT-6	

704.7 – DENSITY OF SOIL IN-PLACE BY THE NUCLEAR GAUGE METHOD (AASHTO T 238)

1. Scope - This method of testing may be used for determining the in-place density and moisture content of base courses and soils, especially glacial till soils compacted at moisture contents above optimum.

2. Special Precautions - The nuclear gauges used in this test rely on sources of radioactive isotopes. The isotopes are lead shielded and encased in the instrument. Extension of the source rod beyond the shielded instrument case permits the radioactive particles to escape. The quantities of radiation emitted are quite small, so the operator may safely use a gauge day after day without receiving any bodily damage due to radiation. **All radioactive sources, no matter how small, should be handled with care.**

State law requires that the operator of a nuclear gauge be licensed by the Radiation Control Section, Occupational Health Division, Department of Health. In order to obtain

a license, it is required that the operator complete a short course in Radiation Safety given by the Manufacturer's Training Officer, a licensed Nuclear Regulatory Commission instructor.

In order to protect the operator from possible overexposure to radiation, the Department supplies a radiation monitoring dosimeter. The dosimeter must be worn at all times while using or transporting the nuclear gauge.

The operator must study and become knowledgeable in the contents of the instruction manual supplied with the nuclear gauge.

Unauthorized access to the gauge should be prohibited at all times.

The gauge must be locked up or otherwise secured when not in use.

3. Apparatus - A factory calibrated Nuclear Gauge such as the Troxler 3411 and the Instruction Manual for the Gauge (see figure on following page).

A Reference Standard (see figure on following page).

A scraper plate (with drill rod guide) for smoothing the test site and drilling the access hole.

Drill Rod.

A 4-6 lb (2-3 kg) hammer for driving the drill rod, a #4 (4.75 mm) sieve, a shovel and a field scale.

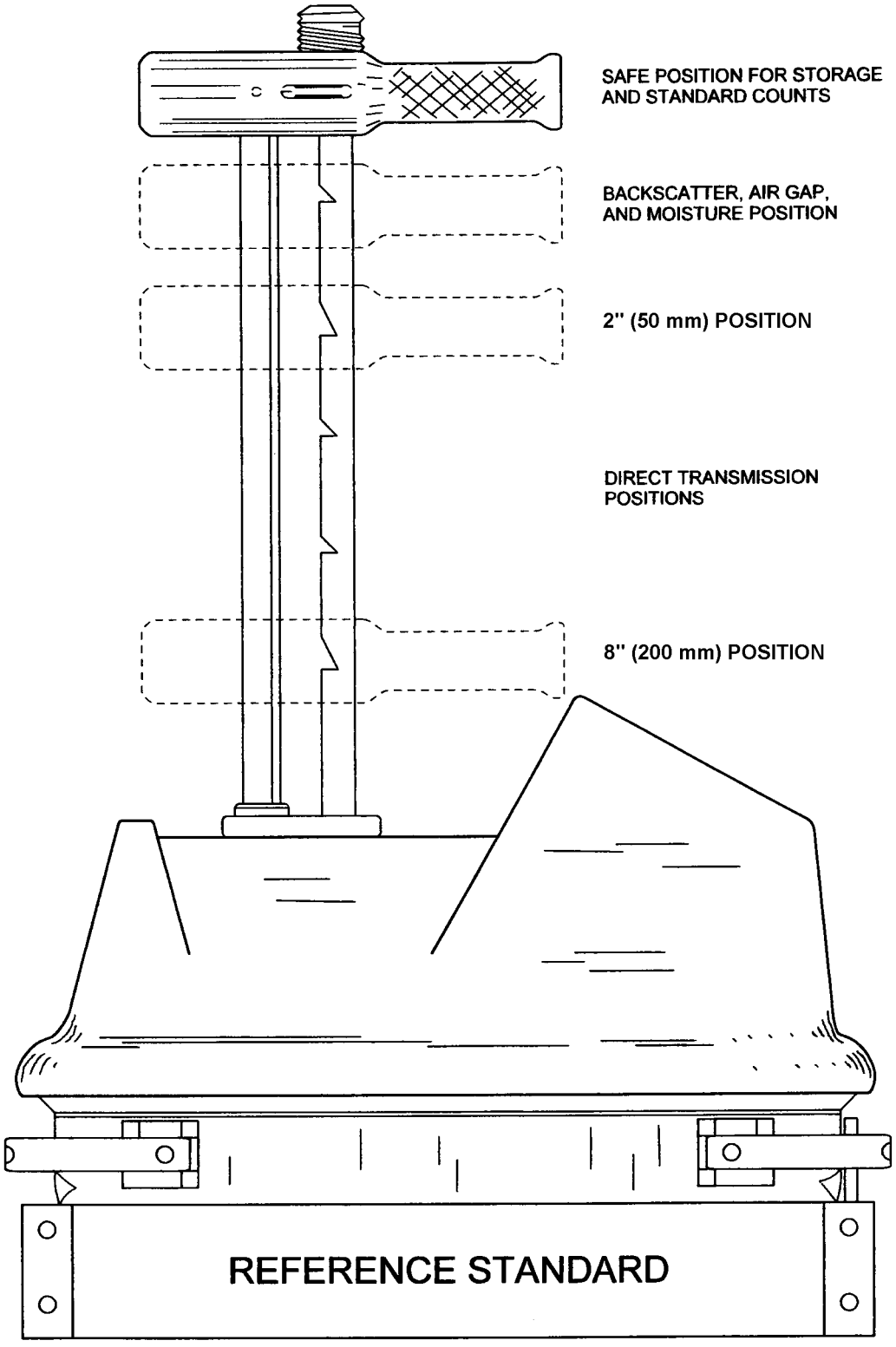


Figure 4: Nuclear Gauge Density Apparatus with Reference Standard

4. Determination of Maximum Dry Density on Crushed Stone Bases - The maximum dry density of a base course, such as a crushed stone base (Items 304.4 and 304.5) is obtained by the use of a test section. Material from the stockpile is spread on the project in an area approximately 200 feet (60 m) long by 10 feet (3 m) wide. The depth of the material should be such that after compaction a 10 to 12 inch (250 to 300 mm) thickness is in place to allow for a test penetration of 8 inches (200 mm). Compact the area with a 27,000 pound (120 kN) dynamic-force vibratory roller for a specific number of passes for each density test.

Nuclear gauge density data is obtained at the same location on each series of passes. The process of compaction passes and testing is continued until there is a decrease in dry density or the density remains the same for two tests in a row. The highest dry density obtained by this process is then considered the maximum dry density obtainable. All future tests for determining the percent compaction on the crushed stone base will be related to the maximum dry density obtained on the test section. If the source of material changes substantially for any reason or compaction results suddenly become consistently low or high, a new test section shall be established and the testing process shall be repeated. It is not necessary to correct the maximum dry density obtained on a test section of the crushed stone base material for the percent of stone retained on the #4 (4.75 mm) sieve.

5. Determination of Maximum Dry Density on Soil Materials - The maximum dry densities for coarse granular soils and glacial tills are obtained by the Proctor Test, previously described under the procedure "Testing Soil for Moisture-Density Relations" (page 26). Remember to correct the Proctor maximum dry densities for the percent of stone retained on the #4 (4.75 mm) sieve.

The Nuclear Density Test Report forms shown below are used for reporting nuclear gauge test data and results.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

FIELD REPORT ON NUCLEAR DENSITY TEST

Project Laconia **Fed No.** NHS-018-2 (104) **State No.** 99999

Date 04/15/03

Material Sand **Submitted By** R. Tanner
Source Ford Sand & Gravel **Town** Belmont, NH

Quantity Represented 1000 CY +/- **Item No.** 304.1

Report To: ☒ **Project Files** ☐ **Lab** ☒ **Contractor** Plow Bros., Inc.

Test Number	7					
Test Depth (in)	8”					
Station	123+50					
Location (Lt-Rt)	Lt 10’					
Height of Fill (Ft)	10’					
Wet Density (PCF)	121.9					
% #4 Stone Retained	0.0					
% Moisture	7.3					
Dry Density (PCF)	113.6					
Proctor or Test Strip	115.4					
Corrected Dry Density	115.4					
% Compaction	98.4					
% Required	95					

Remarks **Meets requirements for Item 304.1 Sand**

Tested By: **E. Welch** **on (date)** **April 15, 2003**

State of New Hampshire Department of Transportation
Bureau of Materials and Research

Nuclear Density

Sample ID:	*AA07713*		
Project:	**ENFIELD**	***Federal No:***	STP-TE-BRZ-T-X-145(2)
Proj No:	10652	***Source:***	Pike Industries, W.
NH Lab No:	03-0415KC1	***Report***	Charles Flanders
Material:	Granular Backfill	***Submittal***	4/18/2003 2:15:00
Sampled from:	B# 083/156, Shaker Hill	***Sample***	4/15/2003
Lot #:		***Sampled by:***	E.W. & K.C.
Purpose:	209.201		

Analysis Validated JA ***Date:*** 4/29/200 ***Sample Validated*** ADP ***Date:*** 4/29/2003

Remarks: Geo Gauge informational comparison test(s) in same test location: 7.03 Avg. Stiffness

METHOD VIOLATIONS	***ANALYSIS***	***RESULT***	***UNIT***	***MIN***	***MAX***
	Gauge ID	20730			
	Calibration/Verification Date	03/03			
	Standardization Data	2043/672			
T310	Test Depth	8	inches		
T310	Height of Fill	20	Feet		
T310	Wet Density of soil	142.2	lbs/ft3		
T27	No 4 (4.75mm) Sieve	55	% Retained		
T310	Weight of H2O in Sample	4.8	lbs/ft3		
T310	% Moisture	3.5	%		
T310	Dry Density	137.4	lbs/ft3		
T99	Maximum Dry Density	125	lbs/ft3		
T224	Corr. Max. Dry Den.	138	lbs/ft3		
	% Compaction	99.6	%	95	
	Tested By:	E.W. & K.C.			
T310	% Moisture (IA)	2.9	%		
	Meets Comparison?	Satisfactory			
T310	Dry Density (IA)	138.2	lbs/ft3		
	Meets Comparison?	Satisfactory			
T310	Wet Density of Soil (IA)	142.3	lbs/ft3		
	Meets Comparison?	Satisfactory			
T310	Weight of H2O in Sample (IA)	4.1	lbs/ft3		
	Meets Comparison?	Satisfactory			

Comments: Project T99-A Proctor MDD = 125 pcf @ 9% om; see LIMS Report #'s AA07620 and AA07619 for test results from same sample location

704.8 – STRAIGHT LINE ANALYSIS AND CHARTS

In order to readily evaluate whether materials and other necessary tests made on projects conform reasonably to the Specifications both during the construction phase and at the completion of the project, the project personnel might opt to use straight line analysis charts.

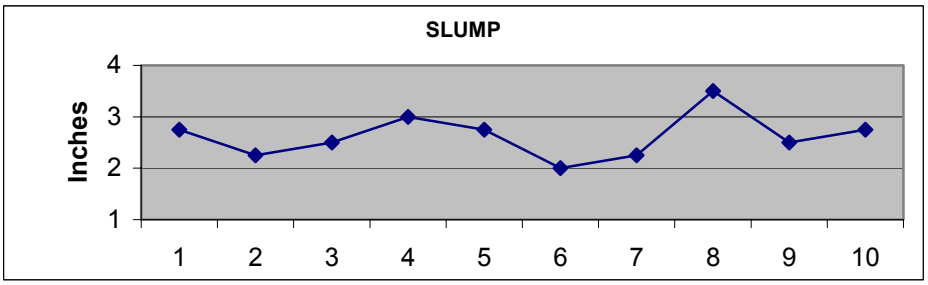
These charts can be of considerable visual value to the Department, both during field inspection by supervisory personnel and during the documentation of materials and tests for federal reimbursement upon completion of the project.

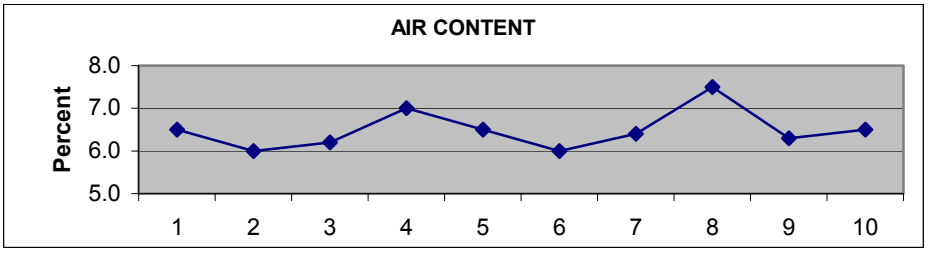
These charts are generally kept in files along with the test reports of the Item they represent. In order for these charts to be of value, they must be maintained in an up-to-date status and available for field inspection by contractors, suppliers and/or the Federal Highway Administration.

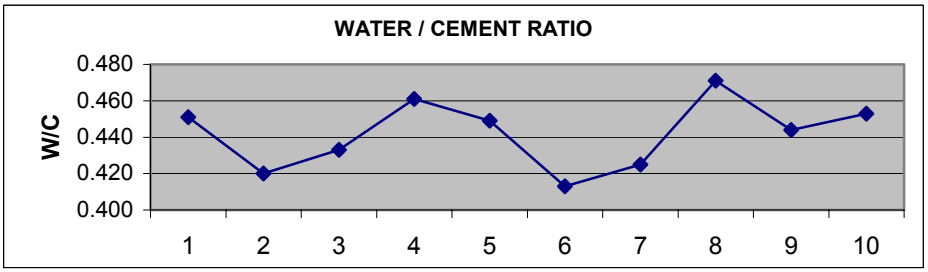
Charts might be maintained on the following items, or on any other item with multiple test results that the Contract Administrator or District Construction Engineer designates:

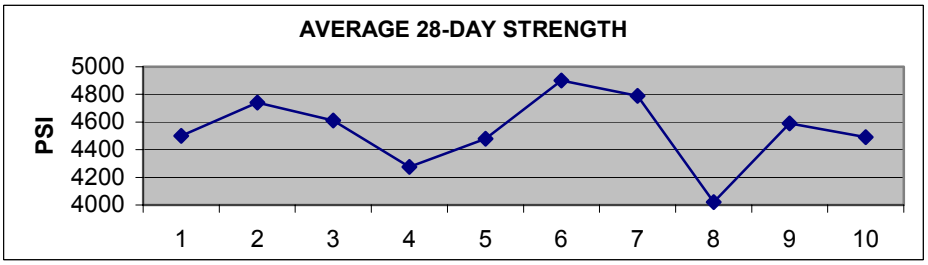
Fill	-	in-place density
Sand	-	gradation, in-place density
Gravel	-	gradation, in-place density
Crushed Gravel	-	gradation, fractured faces, in-place density
Concrete	-	slump, entrained air content, water/cement ratio, compressive strength, permeability, sand FM

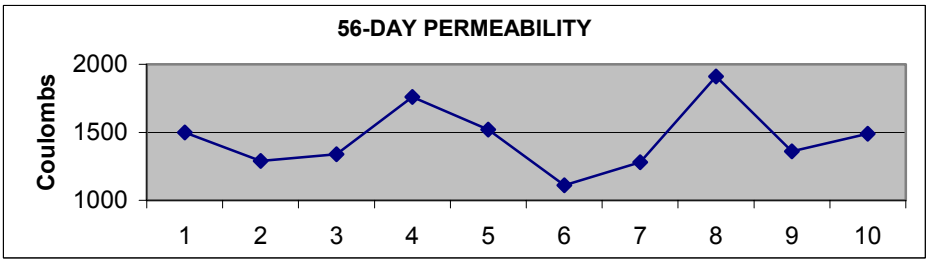
An example of a Straight Line Analysis Chart for concrete test results is shown on the following page.

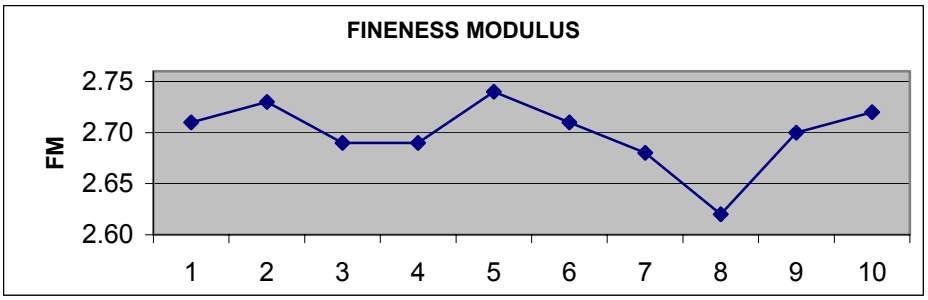

SLUMP
Inches
4
3
2
1
1 2 3 4 5 6 7 8 9 10


AIR CONTENT
Percent
8.0
7.0
6.0
5.0
1 2 3 4 5 6 7 8 9 10

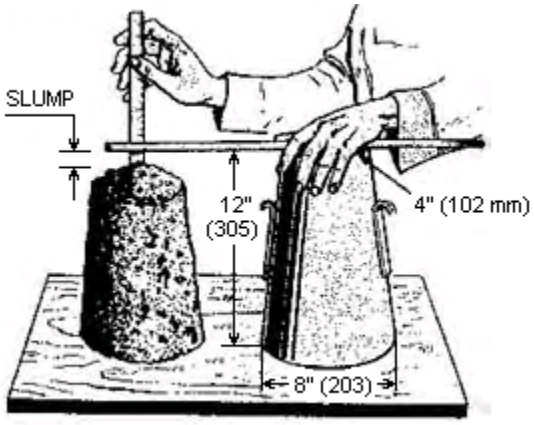

WATER / CEMENT RATIO
W/C
0.480
0.460
0.440
0.420
0.400
1 2 3 4 5 6 7 8 9 10


AVERAGE 28-DAY STRENGTH
PSI
5000
4800
4600
4400
4200
4000
1 2 3 4 5 6 7 8 9 10


56-DAY PERMEABILITY
Coulombs
2000
1500
1000
1 2 3 4 5 6 7 8 9 10


FINENESS MODULUS
FM
2.75
2.70
2.65
2.60
1 2 3 4 5 6 7 8 9 10

704.9 – STANDARD METHOD OF TESTING THE SLUMP OF PORTLAND CEMENT CONCRETE (AASHTO T 119, ASTM C 143)



SLUMP CONE

1. Scope - This test covers the procedure to be used for determining the slump of Portland cement concrete, both in the laboratory and in the field.

2. Apparatus - Mold in which to form the specimen. The mold shall be made of metal not thinner than 0.060 inches (1.5 mm). It should be in the form of a cone, and the base and the top should be open and parallel to each other. The base should be 8 inches (203 mm) in diameter, the top should be 4 inches (102 mm) in diameter, and it should be 12 inches (305 mm) tall. The mold shall be provided with foot pieces and handles.

A round, straight steel tamping rod. The tamping rod shall be 5/8 inches (16 mm) in diameter and approximately 24 inches (600 mm) long. One end of the rod should be rounded to a hemispherical tip.

A sample of concrete obtained per ASTM C172 representative of the entire batch from which the test specimens will be made.

3. Procedure - Dampen the mold and place it on a flat, moist, non-absorbent, rigid surface. The operator shall hold the mold firmly in place during filling by standing on the two foot pieces. From the sample of concrete obtained in accordance with 2 above, immediately fill the mold in three layers where each layer fills approximately one third of the volume of the mold. One third of the sample fills the mold to a depth of 2 5/8" (70mm) and two thirds fills the mold to a depth of 6 1/8" (160mm).

Rod each layer with 25 strokes of the tamping rod. Uniformly distribute the strokes over the cross-section of each layer. For the bottom layer, this will necessitate inclining the rod slightly and making approximately half the strokes near the perimeter, and then progressing with vertical strokes spirally toward the center. Rod the bottom layer throughout its depth. Rod the second layer and the top layer each throughout their depth, so that the strokes just penetrate into the underlying layer.

In filling and rodding the top layer, heap the concrete above the mold before rodding is started. If the rodding operation results in subsidence of the concrete below the top edge of the mold, add additional concrete to keep an excess of concrete above the top of the

mold at all times. After the top layer has been rodded, strike off the surface of the concrete by means of a screeding and rolling motion of the tamping rod. Remove the mold immediately from the concrete by raising it carefully in a vertical direction. The operation of raising the mold should be performed in approximately 5 seconds by a steady upward lift with no lateral or torsional motion being imparted to the concrete.

The entire operation from the start of the filling through removal of the mold shall be carried out without interruption and should be complete within two and a half minutes.

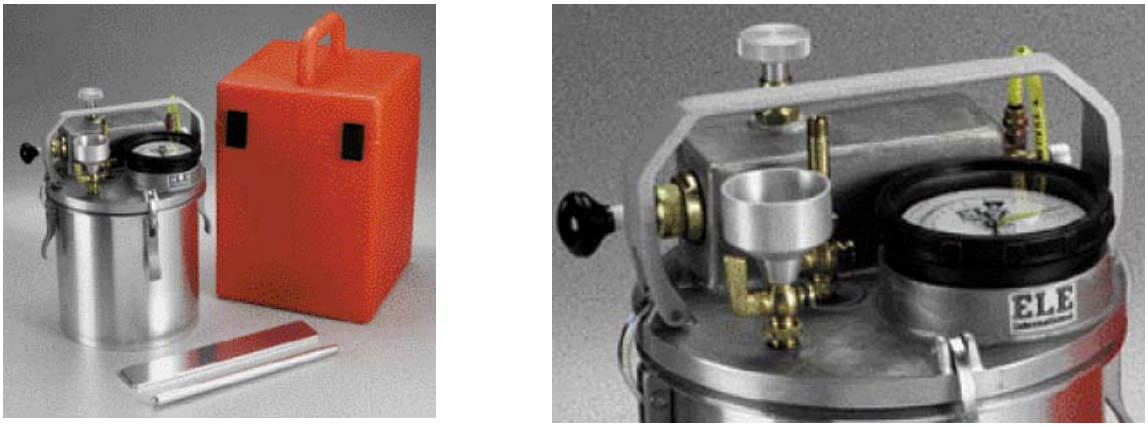
Immediately measure the slump by determining the difference between the height of the mold and the height over the original displaced center of the top of the specimen. If a decided falling away or shearing off of concrete from one side or portion of the mass occurs, disregard the test and make a new test on another portion of the sample.

If two consecutive tests on a sample of concrete show a falling away or shearing off of a portion of the concrete from the mass of the specimen, the concrete probably lacks the necessary plasticity and cohesiveness for the slump test to be applicable.

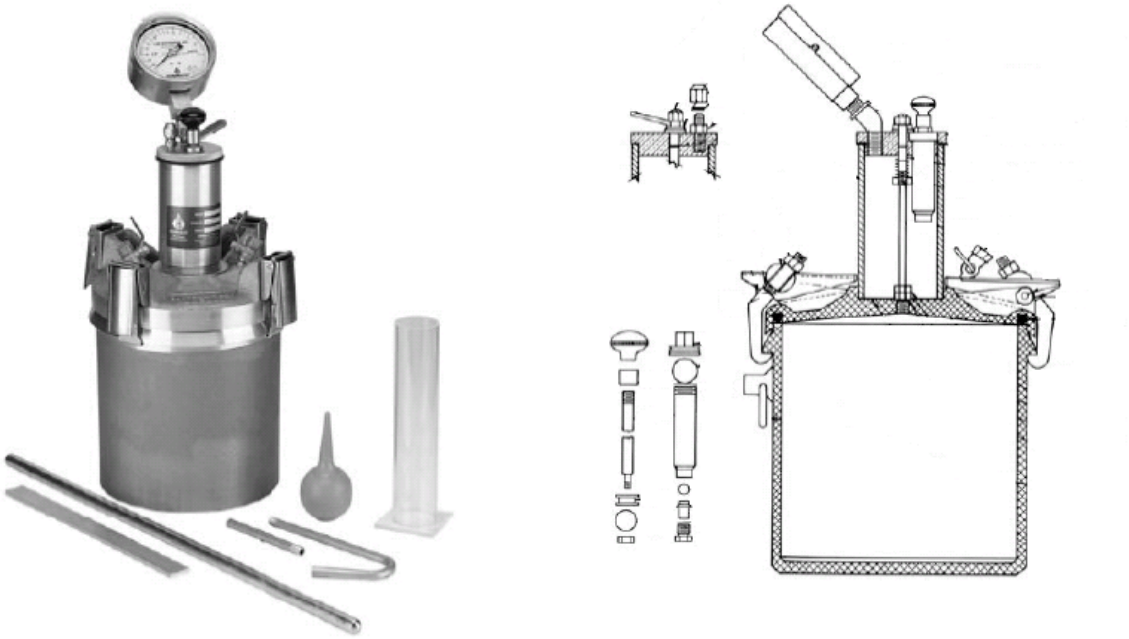
4. Report - Record the slump in inches (millimeters) to the nearest 1/4 inch (5 mm) of subsidence of the specimen.

Slump = Distance from top of cone to top of displaced center of sample.

704.10 – DETERMINING ENTRAINED AIR IN CONCRETE WITH A PRESSURE METER – (AASHTO T 152, ASTM C 231)



Style 1



Style 2

TYPE B PRESSURE METERS

The range of air content designated in the Specifications applies to the air content of the concrete as it is deposited into its final location. When the site of deposit is remote from the truck mixer, such as when the concrete is pumped or moved from the mixer to its final location by conveyer belt, air tests may be run at the mixer for informational purposes only to assist the Contractor in obtaining air contents within the Specification range at the point of deposit. Type A pressure meters are less common than the Type B

today and are typically not used in the field, but their function is still based on the same basic principle to measure entrained air content in the concrete.

1. Operating Instructions for Type B pressure meter:

Place a sample of the concrete to be tested in the material container in three equal layers. Rod each layer 25 times uniformly over the area of the lift with the hemispherical end of a 5/8" (16 mm) rod such that the rod slightly penetrates the prior lift. Be sure to tap the sides with a rubber mallet 10 to 15 times after rodding each layer to ensure that the voids left by the rod are filled. Excess concrete should be removed by sliding the strike-off bar across the top flange of the material container, using a sawing motion, until the container is just level-full.

Wipe the top rim of the container clean.

Place the lid on the material container and close the four clamps (close opposing clamps simultaneously).

Style 1: Close the main air valve located on top of the air receiver. Open both petcocks located on top of the lid. Pour water into the funnel until water comes out of the petcock in the center of the lid. Tip and gently jar the meter until no air bubbles come out through the center petcock.

Close the air bleeder valve in the end of the air receiver and gently pump air into the receiver until the gage hand comes to the red line. A little to one side or the other of the line will make no difference as long as the hand has gone past the initial starting point.

Tap the gage gently with one hand. At the same time, crack the bleeder valve in the end of the air receiver until the gage hand rests exactly on the initial starting point. Then quickly close the bleeder valve.

Close both petcocks. Open the main air valve between the air receiver and the material container, and tap the container smartly with the rubber mallet when pressure is on to allow for possible rearrangement of particles. Tap the gage gently until the hand comes to rest. This reading is the percent of air entrained. This style meter will typically read up to 22% air.

Once the test is complete, open the petcocks before releasing air from the chamber or releasing the clamps.

Style 2: Open both petcocks located on the top of the lid. Inject water into one of the petcocks until water comes out of the other petcock. Tip and gently jar or roll the meter until no air bubbles come out through the opposite petcock.

Close the air bleeder valve at the top and gently pump air into the air chamber until the gage hand comes go beyond the initial pressure line (determined by calibration). Wait a few seconds and tap the gauge gently until the hand comes to rest. Use the bleeder valve or pump gently as necessary until the hand rests exactly on the initial pressure line.

Close both petcocks. Open the main air valve between the air chamber and the material container by pressing down on the lever located at the top of the chamber. Hold the lever down for several seconds and tap the container smartly with the rubber mallet to allow for possible rearrangement of particles. Tap the gage gently until the hand comes to rest. This direct reading is the percent of air entrained.

Once the test is complete, open the petcocks before releasing air from the chamber or

releasing the clamps.

The "aggregate correction factor" is obtained by placing the amount of each size of aggregate used in the test in the material container with water and completing the regular determination for air content. This factor is typically insignificant but may be subtracted from the original air reading.

2. Field Calibration of Meter - The following procedures should be used for testing the calibration of the meter in the field prior to any concrete testing and monthly thereafter, or any time the calibration is in question.

Style 1: Fill the material container with water. Be sure the meter is in a level position. Remove the standpipe screwed into the petcock and screw it finger-tight into the funnel petcock opening on the underside of the lid.

Wipe the top rim of the container clean.

Close the main air valve on the top of the air receiver. Open both petcocks on the top of the lid.

Place the lid on the material container and close the four clamps.

Pour water into the funnel until water comes out of the petcock in the center of the lid. Jar the meter gently until no air bubbles come out through the center petcock.

Close the air bleeder valve in the end of the air receiver and gently pump air into the receiver until the gage hand comes to the red line. A little to one side or the other of the line will make no difference as long as the hand has gone past the initial starting point.

Tap the gage gently with one hand. At the same time, pump up gently or crack the bleeder valve in the end of the air receiver until the gage hand rests exactly on the initial starting point. Then quickly close the bleeder valve.

Close both petcocks and remove all water from the funnel with a syringe.

Open the main air valve to the material container about 1/2 turn and tap the gage until the hand comes to rest.

Gently crack the petcock under the funnel. When water has risen exactly to the line inside the funnel, close the petcock.

Open the main valve to the material container about 1/2 turn and tap the gage until the hand comes to rest.

If the meter is in perfect working order, the gage hand will come to rest on the proper, calibrated value. This value should be compared to the prior indicated value written on the back side of the gage.

If the gage hand does not come to rest on the proper, calibrated value, the starting point arrow should be readjusted as outlined in the Notes below.

After the test, return the standpipe to its place in the center petcock.

Style 2: Fill the material container with water. Be sure the meter is in a level position. Screw the short straight section of tube into the threaded petcock opening on the underside of the lid.

Wipe the top rim of the container clean.

Open both petcocks on the top of the lid. Place the lid on the material container and close the four clamps.

Inject water into one of the petcocks until water comes out of the other petcock. Tip and gently jar or roll the meter until no air bubbles come out through the opposite petcock.

Close the air bleeder valve at the top and gently pump air into the air chamber until the gage hand comes go beyond the initial pressure line. Wait a few seconds and tap the gauge gently until the hand comes to rest. Use the bleeder valve or pump gently as necessary until the hand rests exactly on the initial pressure line.

Close both petcocks. Open the main air valve between the air chamber and the material container by pressing down on the lever located at the top of the chamber. Hold the lever down for several seconds and tap the gage gently until the hand comes to rest. At this point the gauge should read "0" percent. If two or more tests show a consistent variation from 0%, then change the initial pressure line to compensate. Use the newly established initial pressure line for subsequent tests.

Screw the curved tube into the threaded petcock on top of the lid and set the 5% calibration vessel under the discharge spout of the curved tube. Press the lever down and fill the calibration vessel by gently opening the petcock.

Release the air in the base through the opposite petcock and then open the petcock with the curved tube to allow water to run back into the base from the tube. There is now 5% air in the base.

Repeat the air test to verify that the meter reads 5%. If two or more tests show a consistent variation from 5% ($\pm$ 0.2%), then remove the gauge glass and reset the dial hand to 5% by turning the recalibration screw located just below and to the right of the center.

When the gauge hand reads correctly at 5%, empty the calibration vessel and withdraw additional water in the same manner to check the gauge at 10% and again at 15%.

Notes for Style 1 meter:

a. Always close the main air valve before releasing pressure from either the material container or the air receiver. Failure to close this valve will cause water to be drawn into the air receiver and future measurements will be in error.

Should water be drawn into the air receiver, open the bleeder valve in the end of the receiver and tip the lid so that water runs out the bleeder valve. Several strokes of the pump handle will blow out the last traces of water.

b. If it is suspected that air is leaking from the chamber through the handle, a clutching device in the knob, which allows the handle to skip, may be adjusted by closing the valve as far as it will go and giving the split-nut on top a clockwise turn. This will give added friction to the clutch and ensure positive closure of the needle valve without damage.

c. The pressure gage has an adjustable starting point. Should it become necessary to reset this initial pressure line (i.e. after replacement of the rubber gasket which makes the seal between the lid and the material container), the following procedure is recommended:

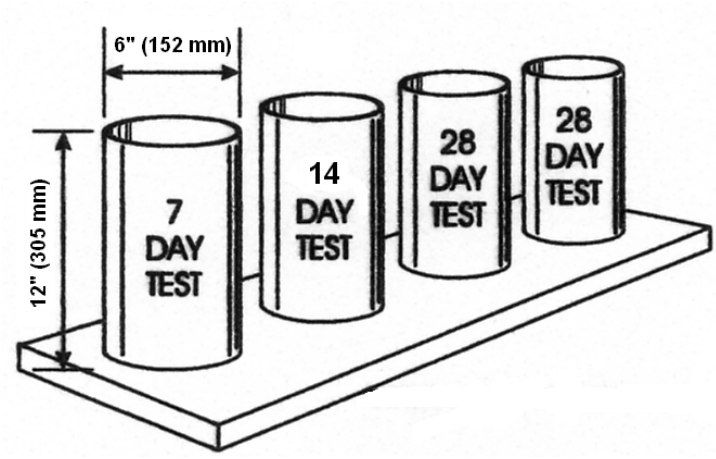
1. Perform the Field Check Test described above. If the gage hand does not fall on the proper, calibrated value, the starting point arrow will have to be adjusted. To reach the starting point arrow, unscrew the retaining ring from gage and remove the glass.

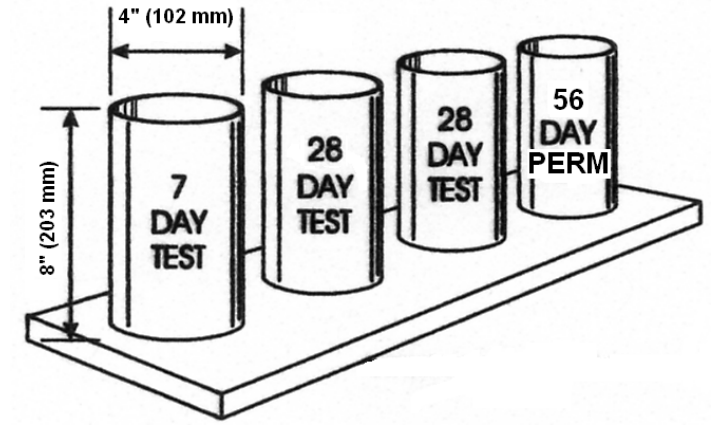
2. If the gage hand falls below the proper calibrated value, advance the starting-point arrow counter-clockwise the same distance as the gage hand falls below it.

3. If the gage hand goes beyond the proper calibrated value, adjust the starting-point arrow clockwise the same distance as the gage hand passes it.

d. The gage hand should not exceed ½ inch (13 mm) beyond red line limit.

704.11 – METHOD FOR CASTING, CURING AND TRANSPORTING CONCRETE TEST CYLINDERS– (AASHTO T 23, ASTM C 31)



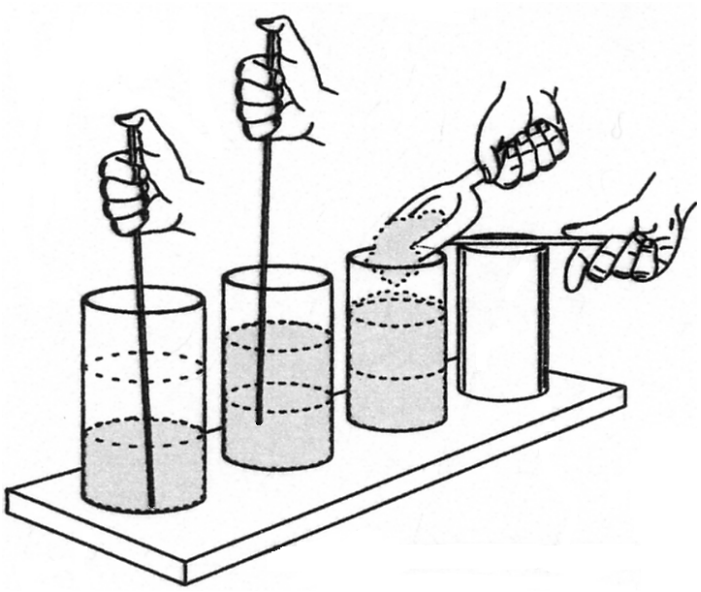


1. Scope - Concrete test cylinders are an important means of determining an estimation of the in-place material's ultimate strength and are often used to give an indication of when forms and falsework can be safely removed. A minimum of two 28-day strength cylinders should be cast from each placement.

2. Apparatus – Plastic, steel or paraffin-sprayed cardboard molds are usually used for casting concrete cylinders in the field. 6" (152 mm) x 12" (305 mm) molds are acceptable, but 4" (102 mm) x 8" (203 mm) molds are becoming more and more common for most applications and are also used for casting 56-day permeability specimens. A

scoop, strike-off bar and a hemispherical-end tamping rod 5/8" (16 mm) diameter are also needed. NOTE: When casting 4" x 8" cylinders, a 3/8" (9.5 mm) diameter rod must be used.

3. Procedure – Mark up the exterior of each mold with project information, cast date, class and number and place molds on a smooth, firm and level surface. After properly sampling the material, remix the sample to ensure uniformity. Fill 6" x 12' molds in three equal layers (two equal layers for 4" x 8" molds) and rod each layer 25 times uniformly over the area. Tap the sides of the molds after each lift to fill voids left by the rodding. When rodding the upper layers the rod should just penetrate the underlying layer. After consolidating, finish the tops with a sawing motion of the strike-off bar until reasonably smooth. Do not overfinish. Place the molds into a level curing box maintained at 60–80°F (15.6-26.7°C) and immediately cap tightly.



4. Transporting – Test cylinders must be left in the curing box undisturbed until they have attained enough set strength to withstand handling. Generally, cylinders should be transported to the Lab within 3 days to finish their curing in the wet room. Caps should remain on the specimens for the entire duration of the trip to minimize moisture loss. Cylinders should be preferably transported in a vertical position in a box specifically constructed and cushioned for such purpose, but may be laid horizontally if they can be secured without rolling or rattling against each other. During cold weather, every effort should be made to keep the ambient temperature around the cylinders in this range (i.e., in the passenger compartment vs. the bed of a pickup truck). Make out a tag with the project name and number and fill in all of the pertinent information and test results. Include the cylinder numbers and when you wish to have them tested.

NHDOT P1

Modify AASHTO T23 - Making and Curing Test Specimens in the Field as follows:

Specimens that are to be transported to the Laboratory shall remain in the molds until received by the Laboratory.

NHDOT P2

Modify ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders, as follows:

Add to section 6.1, single use cylindrical molds the following: Only 150 mm by 300 mm (6" by 12") shall be used. Cylinder molds shall be modified by drilling a circular series of 1.5 mm (1/16") holes approximately 12 mm (1/2") apart in a 100 mm (4") radius about the center of the bottom of the mold. Two holes shall be drilled near the center of the bottom of the mold. Before placing the CLSM in the mold, the bottom of the mold shall be covered with filter paper.

Delete sections 10, 11, 12, 13,14, and 15.

Testing of CLSM test cylinders shall meet the requirements of AASHTO T 22.

704.12 – TEST OF FINE AGGREGATE USED IN PORTLAND CEMENT CONCRETE

Scope - Fine aggregate used in the production of Portland cement concrete has a definite effect on the design of a concrete mix. Besides influencing the amount of mixing water required to make a workable mix, the mechanical composition of the aggregate is of concern since it affects the strength of the mix. As a result, engineers use an empirical index called the fineness modulus (FM) as a measure of the fineness of an aggregate. In general terms, a fine aggregate with a high FM is coarser than one with a lower FM. For State mix designs, test results of the fine aggregate should not vary from the design FM by more than ±0.2. If a greater variation occurs, a redesign of the concrete mix may be required, even though the FM is within specifications. Please refer to Section 520 for detailed examples of testing procedures for fine aggregate.

704.13 – TEST OF COARSE AGGREGATE USED IN PORTLAND CEMENT CONCRETE

Scope - In addition to the fine aggregate tests, the concrete plant inspector is also required to run a gradation on the coarse aggregate. The procedure is similar to that used to determine the gradation of the fine aggregate. Please refer to Section 520 for detailed examples of testing procedures for coarse aggregate.

Reporting aggregate gradation test results should be made on the following forms and maintained in the project records.

(Rev 3/96)

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

GRADATION TEST REPORT (English)

Project Laconia — Field Test No. TCFA81205 & TCCA81205
Type of Material Fine & Coarse Aggregate — Reported 8/12 20 05
Reported by Ronald Tanner — Received by Lab 20
Report to: Project Files ☒ Lab ☒ Contractor ☐
Sampled 8/12 20 05 At (town) F&S Transit Mix – Laconia
Source of Material J.J. Cronin S&G – Laconia
Sample From Stock Bins Pit ☐ Roadway ☐ Sta
Quantity (Represented or Estimate) 110 tons
Purpose / Location So. Abut, Wing Footings, Bridge #175/238 Item No. 520.01
Tested for: Gradation ☒ FM ☒ % Moisture ☒ on 8/12 20 05

Sieve	Coarse Aggregates and Gravels							
	Size 3/4" 60 %		Size 3/8" 40 %		Size %		Combined Results	Required Spec.
	% Passing		% Passing		% Passing			
6"								
3 ½"								
3"								
2 ½"								
2"								
1 ½"								
1 ¼"								
1"	60.0		40.0				100.0	100
¾"	60.0		30.0				90.0	90-100
½"								
3/8"	34.6		11.9				46.4	20-55
#4	5.9		3.4				9.3	0-10
#8	1.8		0.5				2.3	0-5
#16								
#50								
#200 in Total								
% Fract'd Faces								
	Fine Aggregates and Sands							
	% Passing		Required Spec					
#4	99.9		95-100					
#8	87.5							
#16	70.5		45-80					
#30	47.2							
#50	23.0		10-30					
#100	5.7		2-10					
FM	2.57		2.62 ± 0.2					
#200 in Sand	2.2		0-3					
% Moisture	3.6							

Remarks: Moisture - 4.3% minus absorption factor of 0.746% = 3.6%
Meets requirements for: fine & coarse aggregates See reverse ☐
Tested by:

Timothy Booney
(Signature)

(Rev 3/96)

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

GRADATION TEST REPORT (SI)

Project Laconia — Field Test No. TCFA81276 & TCCA81276
Type of Material Fine & Coarse Aggregate — Reported 8/12 20 05
Reported by Ronald Tanner — Received by Lab 20
Report to: Project Files ☒ Lab ☒ — Contractor ☐
Sampled 8/12 20 05 At (town) F&S Transit Mix – Laconia
Source of Material J.J. Cronin S&G – Laconia
Sample From Stock Bins — Pit ☐ Roadway ☐ Sta
Quantity (Represented or Estimate) 110 metric tons
Purpose / Location So. Abut, Wing Footings, Bridge #175/238 — Item No. 520.01
Tested for: Gradation ☒ FM ☒ % Moisture ☒ on 8/12 20 05

Sieve (mm)	Coarse Aggregates and Gravels							
	Size 9.50	60 %	Size 19.0	40 %	Size	%	Combined Results	Required Spec.
	% Passing		% Passing		% Passing			
150.0								
90.0								
75.0								
63.0								
50.0								
37.5								
31.5								
25.0	60.0		40.0				100.0	100
19.0	60.0		30.0				90.0	90-100
12.5								
9.50	34.6		11.9				46.4	20-55
4.75	5.9		3.4				9.3	0-10
2.36	1.8		0.5				2.3	0-5
1.18								
0.300								
0.075 in Total								
% Fract'd Faces								
	Fine Aggregates and Sands							
	% Passing		Required Spec					
4.75	99.9		95-100					
2.36	87.5							
1.18	70.5		45-80					
0.600	47.2							
0.300	23.0		10-30					
0.150	5.7		2-10					
FM	2.57		2.62 ± 0.2					
0.075 in Sand	2.2		0-3					
% Moisture	3.6							

Remarks: Moisture - 4.3% minus absorption factor of 0.746% = 3.6%
Meets requirements for: fine & coarse aggregates — See reverse ☐
Tested by:

Timothy Booney
(Signature)

704.14 – TEST FOR THE DETERMINATION OF THE WATER/CEMENT RATIO OF CONCRETE BY MICROWAVE OVEN (NHDOT)

Calibration of Microwave Oven:

1. Scope - When the project requires testing the water/cement ratio of the concrete by microwave oven - generally projects involving 10 cubic yards (7.65 cubic meters) or more, it is necessary to calibrate the microwave prior to any placements. This procedure is shown below.

2. Apparatus – Microwave oven (700 Watt minimum) with variable power settings, Pyrex dish.

Sample aggregates as shown in the table below.

CALIBRATION OF THE MICROWAVE OVEN

3/8” (9.5 mm) Aggregate	910 grams
Fine Aggregate	606 grams
Cement	336 grams
H_20	±148 grams

3. Procedure - Oven dry the aggregates to a constant weight.

Weigh out samples of the aggregates, cement, and water to the weights shown.

Obtain the tare weight of the Pyrex dish.

Mix the aggregates and cement in the Pyrex dish. Add water and mix until a homogenous mixture is obtained.

Clean all materials from the mixing spoon with a rubber spatula or small steel spatula, ensuring that all materials are placed in the Pyrex dish.

Immediately weigh the mixture.

Place the Pyrex dish with the mixture in the center of the microwave oven and operate the oven at 50% cooking power. Set the oven to initially cook for 15 minutes then weigh the mixture. Additional five minute drying periods should be used until the mixture reaches a constant weight.

Subtract the constant weight from the original weight. The weight should be equal to the original weight of water added. If weight loss is greater than the original weight of water added, fines are being burned.

Reduce power by 10% increments and repeat the procedure until weight loss equals original weight of water added.

Record the power setting at which the weight loss equals the original weight of water added.

Test Procedure:

1. Tare microwave-safe container

2. Place 2000g $\pm$ 300g sample of concrete into the container

3. Weigh sample in container to the nearest gram

4. Place sample and container into the microwave oven at 50% power (or as determined by the calibration procedure above) for 30 minutes

5. Weigh container and sample to the nearest gram

6. Place into the microwave oven at 50% power (or as calibrated) for ten minutes

7. Weigh to the nearest gram

8. Repeat steps 6 and 7 until a constant weight is achieved (1g or less)

9. Calculate the Water/Cement Ratio as follows:

$$\frac{W}{C} = [(N+1) \times MD] - N \times [(ACA) \times (1 - FA) + (AFA) \times (FA)]$$

Where **MD** = (Wet Weight – Dry Weight)/(Dry Weight) [concrete sample only]

N = Total Aggregate/Total Cementitious [use actual batch weights whenever possible]

FA = Ratio of Sand to Total Aggregate [use actual batch weights whenever possible]

ACA = Absorption of Coarse Aggregate [as decimal]

AFA = Absorption of Fine Aggregate [as decimal]

Report results on the following form:

(Rev 4/96)

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION
MICROWAVE WATER/CEMENT RATIO

Project Laconia **Fed No.** BRF-X-STP(003) **State No.** 12345

Location Abut B Backwall **Class** AA **Date** 04/12/2005

Max Water (Gals/CY) _____ **Target** 0.400 **Load #** 1

Batch Weights From Mix Design or Truck Slip

	Batch Wt	Moisture		
CEMENT			2610	
POZZOLAN			2655	
COURSE AGGREGATE (3/8)				
COURSE AGGREGATE (3/4)	14320	0.015	14108.37	
COURSE AGGREGATE (1-1/2)				
FINE AGGREGATE	9960	0.053	9458.69	
ABSORPTION FACTOR COURSE AGGREGATE			0.0105	= ACA
ABSORPTION FACTOR FINE AGGREGATE			0.0052	= AFA

N = 4.476 **FA =** 0.401

Microwave Result Summary

	TIME (minutes)	WEIGHT (g) Sample + Tare	TARE (g)	Net Wt.	LOSS (g)	% DIFF.
Initial	O	2721.3	706.4	2014.9	N/A	N/A
	30	2581.5	706.4	1875.1	139.8	7.5
	45	2578.0	706.4	1871.6	143.3	0.2
	50	2576.6	706.4	1870.2	144.7	0.1
	55	2575.8	706.4	1869.4	145.5	0.0
Final	60	2575.2	706.4	1868.8	146.1	0.0

MD = 0.078

W/C = (N+1)MD - N[ACA(1-FA)+AFA(FA)] = **0.391**

Actual - Target = -0.009

Miscellaneous Information

Slump	3.75"	Air Temp	48
% Air	6.1	Concrete Temp	65
Unit Wt.	142.4		
Yield	27.1	Tested By	TRB

SECTION 705 - SAMPLE FORMS FROM THE BUREAU OF MATERIALS AND RESEARCH

The following pages are sample forms project personnel will receive from the Lab documenting the results of tests performed on samples received from the project.

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION
BUREAU OF MATERIALS & RESEARCH
CONCRETE MIX DESIGN (English)

Project: Laconia Lab No.: 391X96
Federal No.: NHS-018-2 (104)
State No.: 99999

Report to: ☒ Contract Administrator Ronald Tanner ☐ FHWA ☒ Lab
☐ Other ☐ Construction

Type of Mix: ☐ Non-Vibrated ☒ Vibrated ☐ Air Entrained Slump 2-3 inches
Class AA ☒ A ☐ B ☐ C ☐ T ☐ P ☐ Max. Water/bag cement 5.0 Gal

Source of Fine Aggregate	Coastal-Farmington				
Source of Coarse Aggregate	Coastal-Raymond				
Type of Coarse Aggregate	Gravel ☐ Rock ☒		Chemical Admix. Req.	WRA or Retarder	
Size of Coarse Aggregate	#4 – 3/4″				
Fine Aggregate: FM	2.65		Absorption	0.746	%
Sp. Gr. (Sat. Surf. Dry)	2.632		Solid Wt. (A)	164.24	PCF
Coarse Aggregate: Rodded Weight (C)	95.0 PCF		Absorption	0.438	%
Sp. Gr. (Sat. Surf. Dry)	2.687		Solid Wt. (B)	167.67	PCF
Vol. Cse Aggr. per Vol. of Conc. = b/b_o =	0.64			17.28	CF (D)
Wt. Cse Aggr. per CY of Conc. = (D)	17.28	x (C)	95.0	= (E) 1642	Lbs
Solid Vol. of Cse Aggr. = (E)	1642	/(B)	167.67	= 9.79	CF
Solid Vol. of Cement =	6.91		bags x 0.479 =	3.31	CF
Solid Vol. of Water =	34.6		Gal / 7.49 Gal/CF =	4.62	CF
Volume of Air =	6.0		% x 27 =	1.62	CF
Total Solid Volume except Sand = (F)				19.34	CF
Volume of Sand = 27.00 - (F) = (G)				7.66	CF
Weight of Sand = (G) x (A) =				1258	Lbs
Ratio of Sand to Total Agg.	43 % by wt.		Yield Adj. to Design Mix	☐	

BATCH WEIGHTS (Lbs/CY)

Cement	325	Lbs
Slag	325	Lbs
Coarse Aggregate	657	#4 – 3/8”
Coarse Aggregate	985	3/8” – 3/4”
Coarse Aggregate		3/4” – 1½”
Fine Aggregate	1258	Lbs
Total Water	34.6	Gal
Wet Density	142.15	PCF

Moisture content of Fine Aggregate and Coarse Aggregate should be determined and mix design adjusted prior to batching. Total weight of SSD Fine and Coarse Aggregates remains constant.

Respectfully *Jim Amron* Concrete Supervisor

Respectfully **Alan D. Primrose** Chief of Mat. Tech.

Date Reported *4-12-2005*

Project: Laconia

Date: 04/12/05 BR# 105/104

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION
BUREAU OF MATERIALS & RESEARCH
CONCRETE MIX DESIGN (Metric)

Project: Laconia Lab No.: 391X96
Federal No.: NHS-018-2 (104)
State No.: 99999

Report to: ☒ Contract Administrator Ronald Tanner ☐ FHWA ☒ Lab
☒ Other ☐ Construction

Type of Mix: ☐ Non-Vibrated ☒ Vibrated ☐ Air Entrained Slump 50-75 mm
Class AA ☒ A ☐ B ☐ C ☐ T ☐ P ☐ Max. Water/bag cement 18.9 L

Source of Fine Aggregate	Coastal-Farmington					
Source of Coarse Aggregate	Coastal-Raymond					
Type of Coarse Aggregate	Gravel ☐ Rock ☒		Chemical Admix. Req.	WRA or Retarder		
Size of Coarse Aggregate	4.75 - 19.0 mm					
Fine Aggregate: FM	2.65		Absorption	0.746	%	
Sp. Gr. (Sat. Surf. Dry)	2.632		Solid Wt. (A)	2632	kg/m³	
Coarse Aggregate: Rodded Weight (C)	1494.3 kg/m³		Absorption	0.438	%	
Sp. Gr. (Sat. Surf. Dry)	2.687		Solid Wt. (B)	2687	kg/m³	
Vol. Cse Aggr. per Vol. of Conc. = b/b_o =	0.64			0.640	m³ (D)	
Wt. Cse Aggr. per m³ of Conc. = (D)	0.64	x (C)	1494.3	= (E) 956.3	kg	
Solid Vol. of Cse Aggr. = (E)	956.3	/(B)	2687	= 0.356	m³	
Solid Vol. of Cement =	9.16	bags x 0.0135 =		0.124	m³	
Solid Vol. of Water =	173.3	L / 1000 =		0.173	m³	
Volume of Air =	6	% x 0.01 =		0.060	m³	
Total Solid Volume except Sand = (F)				0.713	m³	
Volume of Sand = 1.00 - (F) = (G)				0.287	m³	
Weight of Sand = (G) x (A) =				755.0	kg	
Ratio of Sand to Total Agg.	44 corrected to 40	% by wt.	Yield Adj. to Design Mix ☐			

BATCH WEIGHTS (kg) PER m³

Cement	195.3	
Slag	195.3	
Coarse Aggregate	422	4.75 - 9.50 mm
Coarse Aggregate	634	9.50 - 19.0 mm
Coarse Aggregate		19.0 - 37.5 mm
Fine Aggregate	703	
Total Water	173	L/m³
Wet Density	2323	kg/m³

Moisture content of Fine Aggregate and Coarse Aggregate should be determined and mix design adjusted prior to batching. Total weight of SSD Fine and Coarse Aggregates remains constant.

Respectfully *Brian T. Kellog* Bituminous Supervisor

Respectfully **Alan D. Primrose** Chief of Mat. Tech.

Date Reported *4-12-2005*

Project: Laconia

Date: 04/12/05 BR# 105/104

W/C RATIO BY MICROWAVE OVEN
NHDOT
BUREAU OF MATERIALS AND RESEARCH

$$MD = \frac{\text{Wet Weight of Sample - Dry Weight of Sample}}{\text{Dry Weight of Sample}}$$ = 0.0745

[1] $$N = \frac{\text{Total Aggregate Weight}}{\text{Cement Weight}}$$ = 4.597

[1] FA = Ratio of Sand to Total Aggregate = 0.40

[1] ACA = Absorption of Coarse Aggregate = 0.0115

[1] AFA = Absorption of Fine Aggregate = 0.0093

1. Found on Concrete Mix Design form

$$\frac{W}{C} = [(N+1) \times MD] - N \times [(ACA) \times (1 - FA) + (AFA) \times (FA)]$$

$= [(4.597+1)(0.0745)]–(4.597)[(0.0115)(1-0.40)+(0.0093)(0.40)]$

$= [(5.597)(0.0745)]–(4.597)[0.0069+0.0037]$

$= 0.4170–0.0488$

$$\frac{W}{C} = 0.368$$

SECTION 706 - CORRECTIVE ACTION

706.1 – CORRECTIVE ACTION

Corrective action must be taken for each failing test and a Corrective Action Report must be prepared in triplicate by the Contract Administrator documenting the corrective action taken. One copy of this report should be retained by the Contract Administrator for project records and attached to the unsatisfactory report. The following is a sample Corrective Action Report showing the proper way to fill out this report. This report is to be filled out for every Lab test that does not meet specifications.

State of New Hampshire
Department of Transportation
Contract Administrator's Corrective Action Report

Project: Laconia
No.: 99999

Reported by: Ronald Tanner
Date: 7/8/96

Unsatisfactory sample Test No. 1905-61 file 240

Material or Test: Cr. Gravel

Nature of Sample or Test: Gradation-lacking large aggregate

Date Sampled: 6/29/96
Date submitted to Lab: 6/30/96
Date results rec'd. from Lab: 7/6/96

Date Taken: 7/6/96

Corrective Action Taken:
Had 1 ½" (37.5 mm) crushed stone added to in-place crushed gravel and worked in with grader at Sta. 66+80 to Sta. 67+80 (Area of questionable material). Upon completion of mixing of the stone with previously placed gravel, a sample for gradation was taken that substantiated acceptable material. This area was then thoroughly compacted with a vibratory roller (two more samples taken to test gradation).

Lab No. of Check Sample (if made and known) 1941-61 file 240 Date Sampled 7/3/96
Date Submitted _____ Date Result Rec'd. 7/7/96

Remarks:

3 areas resampled and tested found to be satisfactory.

1. To be prepared by the Contract Administrator and retained in the project records attached to any unsatisfactory material report submitted after completion of corrective action.

706.2 – NONCONFORMING MATERIAL REPORT

As stated in 706.1, corrective action must be considered for each failing test result. A "Corrective Action Report" must be completed to document the action taken. In some cases however, failing material may not be correctable and nonconforming material may be incorporated into the work (if deemed to be in the best interest of the State). This determination will be made based on sound engineering judgment, including situations where the failing material is considered "substantially conforming" or non-detrimental to the integrity of the work.

Contract Administrators shall complete the "Summary of Nonconforming Material" report for all projects, even if said materials were not incorporated. The form shall be submitted stating such to ensure acceptable documentation. When nonconforming materials are incorporated into the work, the Contract Administrator shall complete the form as shown in the example on the following page.

Include the test report date (date taken, if not reported), test number if appropriate, location of the test or structure, type of material and test performed, and an explanation for the acceptance (i.e. substantial conformance or non-detrimental). The summary shall be signed and dated by the Contract Administrator and submitted with the Project Records to Engineering Audit.

SUMMARY OF NONCONFORMING MATERIAL

PROJECT: Laconia
PROJECT NO: 99999
FEDERAL NO: NHS-018-2 (104)

CONTRACT ADMINISTRATOR: Ronald Tanner
DATE: 12/12/96

DATE REPORTED	TEST NO.	LOCATION/ BRIDGE NO.	MATERIAL (TYPE OF TEST)	EXPLANATION FOR ACCEPTANCE
7/14/96	Cyl. #42	Br. #125/264	Concrete (Strength)	Substantially conforms
7/20/96		Br. #172/216	Concrete (Air)	Substantially Conforms
7/28/96	072896 A	Sta 100+50, Rt.40'	Embankment in Place (Density)	Non-detrimental - (Outside $1^1/_2$:1 Slope influence line)

This form is available to be filled out either manually or electronically for all projects.

SECTION 707 - CEMENT MORTAR

707.1 - GENERAL

This item is most often used in conjunction with the following:

A. Concrete Surface Finishing & Pointing.

B. Stone Masonry.

C. Brick & Block Masonry.

D. Concrete Pipe.

E. Manholes, Drop Inlets & Catch Basins.

F. Curbing.

707.3 - CONSTRUCTION OPERATIONS

The Contract Administrator and field personnel should observe the workers mixing the mortar to ensure that a mix no weaker than one part cement to two parts sand by volume is used. Masonry operations should be suspended in rainy weather or under extremely hot or cold conditions unless the mortar can be protected. In hot and dry weather, mortar should be protected from the sun and kept moist for at least three days. In cold conditions, a housing should be provided which can maintain a temperature well above freezing for three days. Mortar should always be applied to clean, wetted surfaces to obtain a durable bond. Care should be taken to apply mortar to joints in such a way as to ensure that the joint is completely filled.